DOCUMENT RESUME

ED 256 617 SE 045 551

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TITLE Factors Affecting Female Attitude Formation toward Science. Specific Reference to 12-14 Year Old Female Adolescents and Their Affective Orientation toward Middle School Science.
PUB DATE 7 Dec 84
NOTE 118p.; Master's Thesis, University of Cincinnati.
PUB TYPE Dissertations/Theses - Master Theses (042) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Attitude Change; *Females; Intermediate Grades; Junior High Schools; Models; *Operant Conditioning; *Science Education; Sex; Sex Differences; *Socialization; *Student Attitudes; Theories
IDENTIFIERS *Cognitive Dissonance; Science Education Research; Self Perception Theory

ABSTRACT

This paper: (1) briefly reviews the existing literature which supports that female adolescents possess significantly more negative attitudes toward middle school science than do males; (2) examines the process of gender socialization in the United States to establish the socio-cultural and social psychological framework within which an attitudinal change toward science (from elementary school to secondary levels) by female adolescents evolves; and (3) reports a study which proposes that four specific attitude change/formation theories (cognitive dissonance modeling, self-perception, and operant conditioning) operate synergistically with gender-differential socialization processes to produce this phenomenon. Analysis of data (obtained from questionnaires administered to middle school students) suggests that Leon Festinger's theory of cognitive dissonance and B. F. Skinner's theory of operant conditioning (contingent reinforcement principle) do indeed operate within the sex-role socialization process to explain how female negative attitudes toward middle school science evolve. Also, Daryl Bem's theory of self perception was intimated by student responses. Albert Bandura's theory of modeling was not indicated as facilitative in this process. Due to the supportive existing literature for the presence of such constructs in attitude formation however, the lack of modeling indicators may result from the instruments used rather than from theory inapplicability. (Author/JN)

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ED256617

FACTORS AFFECTING FEMALE ATTITUDE FORMATION TOWARD SCIENCE

Specific Reference To 12-14 Year Old Female Adolescents and Their Affective Orientation Toward Middle School Science

Master Thesis
by
Deborah A. Schreiber
December 7, 1984

Submitted to
Science Education Department
University of Cincinnati
for the Partial Fulfillment of
Master Degree in Secondary Education

Previous Degrees
B.S. (Biology) - University of Cincinnati
B.S. (Secondary Education) - University of Cincinnati

SE 045 551

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TABLE OF CONTENTS

	PAGE
LIST OF TABLES	ii
ABSTRACT	iii
CHAPTER	
I. INTRODUCTION	1
Overview	1
Statement of Problem	3
Purpose	5
II. LITERATURE REVIEW	7
Female Adolescents' Affective Orientation Toward Science	7
Science as a Male Domain	18
Science and the Socialization of Females	22
Cognitive Development as Related to Scientific Attitudes	41
Science and Attitude Change/ Formation Theories	49
III. RESEARCH METHODOLOGY	83
Utilization of Questionaire	83
Results of Data Collection	89
Analysis of Data	94
IV. CONCLUSION	98
Discussion	98
Recommendations	99
BIBLIOGRAPHY	101
APPENDIX	
1. Lowery's Projective Test of Attitudes [Part C]	112
2. Follow-up Questionaire	113

LIST OF TABLES

TABLE		PAGE
(1)	Occurrence of Free Responses to Lowery's Projective Test of Attitudes	90
(2)	Occurrence of Responses to Dichotomous Follow-up Questionaire	92
(3)	Occurrence of Free Responses to Follow-up Questionaire	93

ABSTRACT

Existing literature supports that the sex-role socialization process in this country strongly accounts for *why* female adolescents harbor significantly more negative attitudes toward middle school science than do males. *How* such patterns facilitate affective orientations, however, is unclear. This paper proposes that four specific attitude change/formation theories (Cognitive Dissonance, Modeling, Self-Perception, and Operant Conditioning) operate synergistically with gender-differential socialization processes to produce this phenomenon.

Analysis of data suggests that Festinger's Theory of Cognitive Dissonance and Skinner's Theory of Operant Conditioning [Contingent Reinforcement Principle] do indeed operate within the sex-role socialization process to explain "how" female negative attitudes toward middle school science evolve. Also, Bem's Theory of Self-Perception was intimated by responses.

Bandura's Theory of Modeling was not indicated as facilitative in this process. Due to the supportive existing literature for the presence of such constructs in attitude formation however, the lack of modeling indicators may result from the instruments used rather than from theory inapplicability.

CHAPTER I

INTRODUCTION

Female negative attitudes toward educational science prevail in this country. Further, these dispositions appear to accelerate during middle adolescence. Although significant sex-role socialization processes may account for why adverse affective orientations exist, additional research is needed to determine the psychological dynamics of this phenomenon. In the following paragraphs a general overview of the present situation and its implications are presented. A statement of the existing problem and the purpose of this study are also designated.

Overview

Research reports indicate that female adolescents possess significantly more negative attitudes toward science and its related activities than do males. Further, evidence exists which strongly suggests that the development of such dispositions accelerates during the middle school years. Currently, it is unclear as to precisely why and how this phenomenon occurs. Is it the individual female adolescent or the specific science material being taught and method used which are responsible for such negative affections?

Uncovering the specifics of sex-role socialization within this country directs researchers to investigate the

individual female adolescent for answers. Sex-role socialization (or as it is more recently referred to as "gender-differential" socialization) offers an insightful explanation as to <u>why</u> teenage girls (who only a few years earlier were highly interested in the natural phenomena of science in elementary school) withdraw from educational science experiences. Mere discussion of the socio-cultural and social psychological framework within which this attitudinal change occurs, however, restricts further plausible interpretations of the socialization process itself. Although social, educational, and personal aspects of the process of sex-role socialization warrant consideration as constituent influences upon the developing female, a more definitive explanation is required to fully understand this attitudinal change toward science.

To comprehend <u>how</u> the female adolescent arrives at such a negative affective orientation toward middle school science, then, the dynamics of specific attitudinal change theories, synergistic to the sex-role socialization process itself, must be examined. Concurrent with the social, educational, and personal aspects of female development, Bem's Self-Perception Theory of attitude formation, Bandura's Theory of Modeling, Festinger's Cognitive Dissonant Theory, and Skinner's Theory of Conditioning all operate under the auspices of the socio-cultural and social psychological framework. Further, these attitude

change/formation theories not only work within this reference, but enhance it as well. The socio-cultural and social psychological framework serves as the vehicle by which attitude formation theories operate. Simultaneously, this frame of reference is enhanced by the dynamics of change taking place.

In summary, the socio-cultural and social psychological framework of sex-role socialization in this country may explain "why" female adolescents develop negative attitudes toward science. Concurrently, the above mentioned attitude change/formation theories appear to operate synergistically within this reference demonstrating "how" such orientations evolve.

Statement of the Problem

Adolescent female behavior regarding science and science-related activities perplexes not only science education researchers, but practitioners as well. For example, in high school the adolescent female enrolls far less frequently than her male counterpart in physical science courses. She rebuffs opportunities for active manipulation of scientific instruments; and in those science classes she does partake, the female adolescent underachieves. Finally, and to no surprise, upon graduation the female adolescent lacks significant attainment of and participation in science-related careers.

Unfortunately, the consequences of this behavior extend beyond the educational system and into social female adulthood. Although the number of women working continues to increase, underrepresentation of females in science-related occupations persists. The U.S. Bureau of Labor Statistics reports that only 9% of the women working outside of the home today are employed as scientists and engineers.

From the above discussion, it becomes evident that female adolescents (and adults) react quite adversely toward educational science, science-related activities, and technically oriented careers. Further, based on the assumption that behavior is indeed a function of attitude (which will be established later), one may conclude that female adolescents (and adults) harbor very negative attitudes toward science.

Our nation needs scientifically literate individuals (male and female) to accommodate the ever-changing technological requirements of society. To disregard the existence of such negative female adolescent behavior in the schools (which in turn perpetuates the scarcity of scientific attainment by women in the marketplace) is to ignore over half of our country's possible future resources for technological maintenance and advancement.

As the private businesses and government agencies of this country demand increased numbers of chemists, technicians, and engineers, the role of women can no longer

be overlooked. Society can no longer economically, psychologically, or sociologically afford the cost of such wasted potential. Something must be done by educators specifically, and society in general, to improve female adolescents' attitudes toward educational science programs and subsequent obtainment of scientific careers.

Purpose

Any attempt by educators (specifically) and society (in general) to improve female adolescents' attitudes toward middle school science must be preceded by an understanding of why and how such negative dispositions evolved. This paper strives to explain succinctly, yet clearly, those factors which affect female adolescent attitude formation toward science.

The study of sex-role socialization of females in this country serves as the key to unlock this mystery. As society trains young girls to "fit" precisely into predetermined, feminine roles, the maturing female lacks adaptive strengths to deviate. Thus, the socio-cultural and social psychological framework, through which the sex-role socialization process manifests itself, develops and structures female group interaction and collective behavior according to customary beliefs for these individuals. Consequently, science (educational and/or occupational), socially viewed as a masculine domain, provides no entry for

female participation nor provisions for future attainment.

Although young girls in elementary school possess an intrinsic curiosity about the natural phenomena labeled "science," prohibition by society of full participation in the field causes an attitude change to take place. Girls redefine and redirect their affective orientations. How this process works, the mechanics of such a change, can best be understood by correlating the dynamics of specific attitude change/formation theories to the sex-role socialization process.

The purpose of this paper, then, is threefold. First, it briefly reviews the existing literature which supports that female adolescents do indeed possess significantly more negative attitudes toward middle school science than males. Second, it examines the process of gender socialization in this country to establish the socio-cultural and social psychological framework within which an attitudinal change toward science (from elementary school to secondary levels) by female adolescents evolves. And third, this paper reports a study of four specific attitude change/formation theories (Bem's Theory of Self-Perception, Festinger's Theory of Cognitive Dissonance, Bandura's Theory of Modeling, and Skinner's Theory of Operant Conditioning [Contingent Reinforcement Principle]), synergistic to the socialization process, which may demonstrate "how" such a phenomenon is possible.

CHAPTER II

LITERATURE REVIEW

The research cited in this review represents theoretical and empirical support for the onset and persistence of negative female adolescent attitude toward educational science. The categories included are:

(1) female adolescents' affective orientations toward science,

(2) science as a male domain,

(3) science and the socialization of females,

(4) cognitive development as related to scientific attitudes, and

(5) science and attitude change/formation theories.

Female Adolescents' Affective Orientations Toward Science

The true subject in elementary school science class is not so much the world but how to be a person in the world. And how else could a person be, than to notice what's what, and wonder why ? Children find this process natural until they are taught that "noticing what" and "wondering why" and "finding out" are special activities reserved for a special sort of people - specifically scientists (Rossman, 1983). Although most young females have a natural appetite for the ways of learning what we call science, lack of nourishment

in the form of parent and teacher encouragement causes this appetite to fade; the intrinsic interest of these girls for scientific phenomena diminishes (Kahle; Hill and Lynch; Stein; Sherif and Sherif).

Conclusively, research shows that young girls in elementary school possess positive attitudes toward eudcational science and science-related activities (Kahle, 1983; Rossman, 1983; Elkind, 1983; and Haertel, et.al., 1981). They are curious about natural phenomena, and they compete for active participatory roles in science activities. The young female sudents feel competent and successful in class.

However, by late adolescence these same female students graduate from high school harboring very negative feelings toward educational science, occupational science, and general science activities (Brush, 1979; Vockell and Lobonc, 1981; Kahle, 1983; Lawrenz and Welch, 1983). Girls, throughout their late secondary educational years, view any specific science class as simply a means by which to attain particular, socially-accepted, feminine career positions (Byerly, 1984; Hill and Lynch, 1983). Data reveal that science, as an area of intrinsic interest and motivation, no longer exists for the 17-year-old female adolescent student.

Further, to educators' chagrin, late adolescent females' affective orientations toward science, when compared to male counterparts, rate significantly more

negative (Schibeci, 1983; Hardin and Dede, 1975; Nettels, 1924; and Vockell and Lobonc, 1981). Whereas late adolescent males also choose specific science courses with career goals in mind, boys do gain a partiuclar amount of personal pride and satisfaction in their successful participation in science-related activities. Regretfully, this same pride and success is not included in female verbal descriptions of their own science experiences.

Although science education researchers agree that this phenomenon persists throughout the nation's school systems, they debate the actual age of onset. Authors agree however, that female attitude changes toward science accelerate during middle adolescence [ages 12 - 14] (Haertel, et.al., 1981; Rossman, 1983; and Hardin and Dede, 1975). Specific enough to coincide with a unique educational time period (middle school: grades 7th and 8th), further interpretation as to the actual age of onset may be unnecessary (whether it be age 9, 11, 12, or 14). The important point is that during the middle school years female adolescents become particularly adverse to science education and its related activities, and their attitudes are significantly more negative than male counterparts' dispositions at this time.

Attitude Change

Kahle (1983) reports that girls in elementary school express positive attitudes toward science. They exhibit

behaviors of interest, curiosity, and inherent motivation toward science-related "show-and-tell," observation of natural phenomena, and museum-directed field trips. As Rossman (1983) discovered through his teaching experience, during children's early years, before science is separated from other aspects of their lives, it is natural for them to see with scientific eyes almost everying in the world. Elkind (1981) further supports this, generalizing that the child's intellectual curiosity and "eagerness to know" is particularly evident in the early elementary grades.

For females in our society this positive affection, unfortunately, does not maintain itself throughout the formal learning period. As Haertel's (et.al., 1981) research concludes, although there is a general lack of significant overall difference between boys and girls in science learning and its determinants in the early adolescent years (late elementary school grades), this contrasts stongly with the highly significant differences between the sexes in science-related attitudes, behaviors, and aspirations (p. 339) during late adolescence (the last two years in high school).

Further, late adolescent females describe science classes as "boring," and consisting of "facts to memorize" (Kahle, 1983). Lawrenz and Welch (1983) add that late adolescent females perceive science as very difficult, and as a consequence, this perception tends to increase the

students' already high levels of anxiety about succeeding in such courses. Female graduates not only harbor negative attitudes toward educational science, as further supported by Vockell and Lobonc (1981), but in addition they hold very adverse stereotypes of scientists and other personnel in technically oriented careers (Brush, 1979). Although the proportion of all women who are in the labor force has increased steadily in recent years (Leuptow, 1984), the employment has been in traditional occupations that emphasize social factors and support over cognitive and task performance. As specified by Kahle (1983), fewer than 9% of employed women serve as scientists and technical engineers.

Subsequent documented behaviors of the adolescent female provide further insight in support of this attitudinal change toward science which takes place during the middle school years. Harmes (1981) and Brush (1979) reported that girls enroll in fewer and fewer science courses as they advance through school. They rebuff opportunities for active manipulation of scientific equipment (NAEP, 1978), and they underachieve in the science classes they do study (Kahle, 1983; and Yager, 1982). Further, Erb, Smith (1981), and DeBoer (1984) recognize that which Leuptow and Kahle reported to be true - that upon graduation female adolescents avoid technically oriented occupations (even if they seek full-time/life-long careers).

Based on research by Fishbein (1967) and Norman (1975)

which states that behavior is unquestionably a function of attitude, and further supported by McCloskey (1976) who reports that low achievement by females on standardized science measures positively correlates to poor attitudes, it is conclusive that adolescent female students become disinterested, insecure, and generally adverse toward science as they advance from the elementary grades, through middle school and onto completion of high school.

Age of Onset

Although science educational researchers agree that female students do develop negative feelings toward science as they progress through our nation's school systems, they debate the actual age of onset; they disagree as to when (what specific age) this attitude change most obviously becomes evident. However, whether 7, 9, or 13 is the most common age when girls initially become quantitatively adverse and significantly less interested in science than boys, authors to agree that it is the "middle school year" period (ages 12 - 14) when these negative attitudes toward science accelerate (Hill and Lynch, 1983).

In review of the existing literature, Kossman (1983) reveals data that suggest girls as young as eight and nine years of age possess more negative affections for science and science-related activities than males. In contrast, Kahle (1983) reports that nine year old girls, although not

made to feel "successful," do express positive attitudes toward science (whether this pertains to educational science or extra-curricular science activities is not specified). Further, Haertel, et.al. (1983) find negative attitudinal, behavioral, and aspirational orientations toward science not surfacing in females until well into senior high school (late adolescence: ages 17 and 18).

Due to the present disparity, it is important to note the more recent study by Harty and Beall (1984) which involves science attitude measurement of gifted and nongifted fifth graders (age 9 and 10). Although these researchers do not explicitly state that nine year old females noticeably exhibit quantifiably strong negative attitudes toward science, they do show that all 5th grade girls, both gifted and nongifted, express significantly less positive attitudes toward educational science than the boys.

Perhaps the disagreement among researchers regarding the age of onset of noticeably evident negative attitudes toward science by females is simply confusion over semantics. Rather than be concerned with the age at which researchers say "that's it - age 10 is when females begin to feel negatively toward science," one should be more concerned with the time period when such affective orientations begin differing significantly from male counterparts. Regardless of "how negative" is negative, as long as female dispositions differ significantly from males,

that developmental period must be recognized.

With this in mind, Barnett, Kahle, and Blanc (among others) suggest that middle adolescence is indeed the time period when female affective orientations increasingly differ from positive male dispositions. Using Spearman rank-order correlations, Barnett (1975) implies that females exhibit adversion to science-related activities approximately at age 12. Kahle (1983) confirms that 13-year-old female adolescents in her study exhibit negative affection for science. Similarly, the NAEP (1978) finds middle school adolescent girls displaying behaviors quite reflective of negative scientific attitudes..

More explicitly, Blanc (1971) reported that it is in the ninth grade specifically when female students steer clear of physical science courses, with negligible adversion illustrated for such classes a year or two earlier. More recently, Hardin and Dede (1975) reaffirm Blanc, stating that interest inventories show seventh grade girls continue to be interested in science (similar to those positive affective orientations in elementary school), although by the end of the eighth grade and beginning of the ninth grade these female students appear disinterested and withdrawn from such activities.

The concensus of science educational researchers is that during middle adolescence (grades seven and eight/ages 12 -14) females become increasingly adverse to science and

science-related activities. For those authors mentioned (ie. Rossman, Harty and Beall) who feel obvious expression of such negative attitudes begins earlier, at perhaps age eight or nine, it is important to note specifically just what it is that is being reported. In these cases, what the publications actually delineate is that the feelings expressed by females is simply not as positive as corresponding male descriptions. Sporadic feelings of negativism toward science in late elementary school may indeed be present, but acceleration of such feelings by females most noticeably increases during middle adolescence.

Male Counterparts

Due to the question of semantics mentioned in the previous section, it is important to delineate explcitily that the negativism expressed by middle adolescent females toward educational science does indeed differ significantly from those feelings similarly aged male students possess. Schibeci (1983) conclusively states that boys display a much more favorable attitude toward both educational and extracurricular science than girls. Kahle (1983) confirms this for males and females in their late teens. Similarly, Barnett (1975), through extensive male/female-interest-correlation, agrees that the sex difference in attitudes toward educational science is significant.

Further, Hardin and Dede (as noted previously) state that interest inventories show negligible sex differences in seventh grade preferences for science, but significant differences do begin to appear late in the eighth grade and early in the ninth grade. During this time, boys continue a somewhat more positive attitude toward science, while the girls become withdrawn and disinterested. Nettels (1924) and Blanc (1951), via their studies of junior high school students and associated science interests, agree that "real sex differences" exist.

Substantial support warrants the conclusion that female adolescents do possess significantly more negative attitudes toward middle school science than their male counterparts. Many authors, however, refer to the biological sciences as being viewed "less adversely" by females than the physical sciences. This distinction must be clarified. Baird, et.al. (1984) recognize that in general girls do relate more negatively to science than boys. However, when life science (biology, the human body, and health) was the concern, girls exhibited less significantly different dispositions. Schibeci (1983) and Lazarowitz and Hertz-Lazarowitz (1979) report similar findings. They note that females view the biological sciences far less adversely than physical sciences, and thus correlate more closely to boys' dispositions in this area.

Although the above referenced distinction between

biological science and physical science is noteworthy, additional research is needed. Whether middle adolescent girls (ages 12 - 14) recognize such distinctions between academic courses is unclear.

Summary of the available literature reveals that middle adolescent females incorporate significantly more negative attitudes toward science than males. "Why" such a phenomenon occurs (and continues to persist throughout our nation's schools) will be addressed through the examination of the sex-role socialization process in this country. Before delving into this investigation, however, consideration must be given to science as a sex-typed, male-oriented domain.

Science as a Male Domain

The conceptualization of gender at the psychological level reveals two dichotomous categories: masculine and feminine (Freimuth and Hornstein). Consequently, within the sex-role socialization process recognition of specific masculine personal traits and feminine personal traits is constantly delineated. What is important here, however, is the identification of those traits, masculine or feminine, which are common characteristics among accomplished educational science participants.

Accordingly, Handley, Morse, and Yoshur (Handley and Morse, 1984) designed the Science Participation Scale (SPS) as an instrument to measure attitudes toward appropriate gender roles for boys and girls in science activities. The outcome of Handley and Morse's research reflects patterns of projected behavior for males in educational science activities corresponding to those which Bem (1974) describes for sex-stereotyped personal traits of males. The six dimensions of masculinity (as correlated to science activities) are: male dominance in ability, leadership, and achievement, higher risk taking by males, dominance of male inquisitiveness, male assertiveness in science activities, more active general science behaviors, and overall higher expectations for males in science.

Boyer (Kahle, 1983) supports these findings, stating that boys in school are valued for thinking logically,

independently, with self-confidence, and with an appropriate degree of risk taking. Girls on the other hand are valued for their emotional expressiveness, sensitivity to others, dependency, and subjective thinking (Barry, et.al. (1957). Barry confirms that social pressure toward nurturance, obedience, and responsibility is most often stronger for girls, whereas pressure toward achievement and self-reliance are most often stronger for boys (p. 328). Further, in intragroup competition (as Amidjaja suggests occurs in the science classroom), boys tend to be the more active and principle initiators, whereas girls manifest concern for fairness, equalization of outcome, and strong orientations towards social interaction (Amidjaja and Venacke, 1965).

Establishing that the above referenced "masculine" traits positively correlate to science activities provides grounds for additional research which finds that science is indeed a male domain. As Kahle notes (1983), clearly the ratio of boys outnumbers the girls in high school science classrooms. Typically, a girl who wishes to pursue advanced science courses finds that such proportions reinforce the socially accepted statement "girls don't become scientists" ([Skolnick, p. 40] Kahle). Whereas boys encounter social acceptance of their scientific intentions as appropriate and admirable, particularly in terms of future economic status and a successful career, girls find ambivalence, lack of encouragement, and messages that what they are doing

(attainment in science) is inappropriate, impractical, and unacceptable (Kahle, 1983; and Lee, 1984).

Similarly, Bossert (1981) notes that teenage girls view success in science as unfeminine. Vockell and Lobonc, as well, find that females consistently refer to physical science courses as "masculine" (p. 272). In agreement, Hill and Lynch (1983) find eleven and fourteen year old girls who believe risk-taking (as correlated to science activities above) is "more boyish" (p. 207), and "aspirations to science-related occupations" (unless in a supportive role) are not "female-appropriate" (p. 208). Society (in general), but more importantly, middle adolescent females, consider science and scientific attainment a male's prerogative.

Due to the much publicized women's movement of the 1960's and 1970's many readers may reject the above citings and the subsequent allegation regarding "science as a male domain". The public's conception of overwhelming change within the sex-role socialization process in this country however, is unsubstantiated. While clear evidence exists on the change of patterns of female employment, studies concerned with sex-typed experiences at social, interpersonal, and personal levels return a picture of sex role stability rather than sex role change (Leuptow, 1984). It is true that since 1950 the proportion of all women who are in the labor force has increased from approximately one-third to one-half. However, the pattern of this

employment still emphasizes traditionally "feminine" occupations. Outside work by the female still entails social factors and support (secretarial and nursing positions) over cognitive and task performance (Leuptow, p. 16). Science (whether educational or occupational) exists within the realm of masculine borders. Society, and middle adolescent females specifically, strongly feel that participation in science is the male's priviledge.

Science and the Socialization of Females

The study of sex-role socialization of females during adolescence in this country serves as the key to unlock the mystery of "why" female adolescents believe that science is a male's domain and thus harbor negative attitudes toward middle school science. As American society trains young girls to "fit" precisely into predetermined, feminine roles, the maturing female lacks adaptive strengths to deviate (emotionally and behaviorally). The socio-cultural and social psychological framework, through which the sex-role socialization process manifests itself, develops and structures female group interact and collective behavior according to customary beliefs found appropriate for these individuals. Consequently, science (educational and/or occupational), socially viewed as a masculine domain, provides no entry for female participation or provisions for future attainment.

It is important to explicate what the socio-cultural and social psychological framework encompasses. The socio-cultural influence includes parent, peer, and teacher directives which aid in the development, structure, and interaction of the colelctive behevior of female organized groups, with intellectual and moral faculties derived from customary beliefs and social reforms. The social psychological aspect of this frame of reference in which sex-role socialization manifests itself refers to the mental

and behavioral characteristics of a female individual or group which reflect adaptation to social needs and uses. Under the auspices of a socially derived self-conept, the female adolescent expresses her behavior in terms of self-social reactions and self-as-student.

The following section of this paper examines parents, teachers, and peers as constituent socio-cultural influences upon the female during adolescence. The result of these influences, the social psychological aspect of self-concept as it is derived through the sex-role socialization process, is then described. Further, correlations are cited which relate this socially attributed self-image to scientific achievement and attitude.

Socio-Cultural Influences

During adolescence (specifically the middle school years) male and female students strive for social maturation (Thornburg, 1982). They pursue satisfactory interaction and adjustment to their environment. The ideas, beliefs, and values of their culture become increasingly significant. To adolescents, understanding and interpreting social and cultural phenomena are distinctly important as skills in adjusting to their society.

The socialization process operates under two realms: that which incorporates gender-differential characteristics, and that which does not. In this country sex-stereotyped

personal traits (as correlated to science activities) are socially agreed to be masculine. Further, ambivalence and lack of encouragement by parents and teachers (Kahle; Lee) cause adolescent females to respond to middle school science achievement (specifically) and occupational science aspirations (generally) as truly a male prerogative. (Support for this allocation follows below.) For this reason, it is important to look at constituent influences within the gender-differential socialization process which explain "why" negative female affective orientations toward science develop.

Within the socio-cultural framework of sex-role socialization, parents, teachers, and peers constitute the most influential toward the developing female adolescent and the resulting negative attitudes toward science. Although increased peer interaction and friendship stability become markedly visible during the middle school years, parents and other adults (teachers) remain relevant sources for learning social behavior.

Parents. Emmerich (1978) concedes that parental advice and direction to the developing adolescent child may be challenged by peer influences. However, her study shows the relative importance of parents and peers on decisions made by ninth grade adolescent females varies with the situation. For example, female subjects are more likely to select the alternative favored by peers when the decision concerns

which of two dresses to buy, but they are more apt to select the alternative which parents favor when the situation involves whether or not to take a part-time job, or whether one type of job is more appropriate than another (p. 176). Summarily, ninth grade girls rely heavily on parental opinion when long-range, important, and difficult choices are involved (Nielsen, p. 151).

Bondi and Wiles (1979) confirm Emmerich's findings for eighth grade girls. Although the review of literature on pre- and emerging adolescent learners discuss the movement of youngsters away from adult influence toward dominant peer association, these researchers find this assumption to be less accurate than previously believed. In this partiuclar survey, Bondi and Wiles report that eighth grade female students rate Family as the most important and influential aspect in their lives.

Within the sex-role socialization process parents exert strong influences over their female adolescent children. Kahle (1983) reports that girls do not excel in middle school science courses because parental expectations for them in this area are low. Low parental expectation, along with minimal evaluation and encouragement, foster the dimished performance and achievement levels of female adolescents (Lee, 1984). As a result girls develop negative affections for science due to parental reactions to their behavior.

Barnett further confirms this but in a more general sense. She reports that parental sex-role attitudes significantly affect child-rearing practices for females but not specifically so for males (1981). For parents with traditional sex-role attitudes, independence granting for female children surfaces at a much later age than for females whose parents possess non-traditional sex-role attitudes. Concurrently, parents with traditional sex-role attitudes incorporate a much lower level of pressure for achievement than parents possessing non-traditional orientations. Both these traits, dependence and low achievement pressure, were previously found to be opposite those correlated to science activities. Thus, girls maturing and growing under the influence of traditional parental sex-role attitude develop characteristics least likely to enhance positive scientific affections and future attainment in this field.

Lee (1984) believes that the ever-influential position of traditionally oriented parents represents coninuing myths concerning masculinity and feminity. The "Cinderella Myth" (p. 328) persists, she explains, which sex-types middle adolescent girls as simply "marking time waiting for Mr. Right to come along" (p. 329). Hill and Lynch (1983) support these findings. As reproduction maturity becomes imminent in their daughters, traditional parents respond in a variety of ways to ensure their female child's fittedness for marriage.

These parents encourage not only virginity, but also "compliant femininity" in their daughters (p. 203). As Lee points out, parents are often willing conspirators in the perpetuation of the Cinderella Myth to the detriment of their developing female children. Girls learn through parental influence that the investment of time and energy in school on more difficult subjects such as physics and chemistry is not only "unfeminine" but unnecessary in light of future marital goals.

Although Bielby (1978) and Barnett (1981) both acknowledge that non-traditional maternal influences result in the socialization of more assertive and competitive daughters (traits strongly correlated to positive scientific attitudes), research remains unclear as to whether this propagates true educational science achievement and positive occupational science aspirations or whether this competitiveness and assertiveness is simply manifested in supportive rather than task performance roles (Leuptow, 1984; and Duncan and Duncan, 1978). Further, as supported by the above discussion, the majority of parents are not "non-traditional" but rather very sex-typed in their child-rearing practices (this particularly pertains to parental relationships with daughters who have reached pubertal maturation, as Hill and Lynch (1983) indicate). Consequently adolescent daughters socially mature disregarding the characteristics most common to successful

scientific attainment and future postive scientific attitudes.

Teachers. In reviewing specific teacher behaviors influential within the sex-role socialization of female adolescents, it is important to consider why not only teachers, but parents and peers as well elicit such directive power over developing middle school age females. As Hill and Lynch (1983) suggest, the intensification of sex-role socialization during this period ensues because of amplified parent, peer and teacher reaction to the pubertal status of the middle adolescent female. Upon reaching sexual maturity females encounter a high premium placed on being socially successful (marriage oriented), attractive to boys, and on giving up masculine activities and interest (Stein, 1976). Girls are rewarded by parents and teachers for conformity, dependence, passivity, and compliance. They are clearly socially ostracized for reverse traits. Upon pubertal maturity competition is considered aggressive and unfeminine, and in the most traditional sense, if these traits are possessed by a middle adolescent female she is led to believe this deviation will threaten heterosexual relationships (Hill and Lynch, 1983). During adolescence (specifically the middle school years which coincide with pubertal maturity) the female student is questioning her own femininity. She receives intense social pressure to be "feminine" but she is not sure quite what this entails

([Brooks-Gunn and Matthews, 1979] Hill and Lynch). Consequently, the female adolescent looks to parents, teachers, and peers for specific answers and guidance.

Corresponding to the previous discussion "Science as a Male Domain," the above mentioned "feminine" traits are directly opposite those identified as traits (pointedly masculine) correlated to science activities. Within the school environment specifically, Byerly (1984) confirms that affective support and affect level, as established by teachers and administrators, appear to be significant factors in the attainment of scientific literacy by female adolescents (and subsequent positive scientific attitudes as noted by McClosky, 1976). The reason why female adolescents do not incorporate such science-correlated affective characteristics within their repetoire, then, is because teacher overt encouragement and instructional strategy, which would promote such affect and feelings of psychological comfort within the educational science arena, are not present in the classroom. As Benz, et.al. report (1981), the majority of teachers (both male and female) possess stereotypic connotations of sex-typed traits and act accordingly. Teachers elicit male (but not female) participation for extended time on scientific equipment and individual discussion of scientific phenomena (Kahle, 1983).

Fox, et.al. (1983) confirm the above assertions. They frequently find principals and guidance counselors reluctant

to place eighth and ninth grade girls in advanced science and math programs even though these girls procured above average SAT scores in these subject areas during the seventh grade. Also, high ability female students receive negative reactions from the school and individual teachers when they are placed in advanced studies. Teachers call less frequently upon the girls to respond in class (Fox). Questions posed by the female students are often abruptly answered and then dismissed (1983). As Fox suggests these negative reactions have a significant and detrimental effect upon the progress and subsequent achievement by the high ability female students. The girls under pressure frequently give into the wishes of the school staff personnel and return to, or repeat lower level courses (1983).

Teachers view [deviant] high achieving females as <u>unfeminine</u> or <u>androgynous</u> (Benz et.al., p. 277). As established earlier, females during the middle school years strive whole-heartedly to establish and incorporate feminine characteristics into their behavior. Because girls are more likely to be influenced by their science teachers than boys ([Ormerod and Suckworth, 1976] Towse, 1983), awareness of such teacher perspectives concerning their achievement in science results in female withdrawal from future exposure to science activities and the subsequent development of negative attitudes toward this field of study (Brickman and D'Amati, 1974).

Peers. Increased peer interaction and friendship stability become markedly visible during the middle school years (Thornburg). As the female adolescent (upon pubertal maturation) searches for answers and explanations regarding her own femininity she looks not only to parents and teachers, but to peers as well for guidance. Lombardi (1963) outlines the importance of peer group influence during middle adolescence with his article "Peer Group Influence on Attitude." He states that during the normal process of socialization the adolescent strives to anchor himself/herself as an acceptable member of groups in his/her social milieu. As a member of the group, the adolescent senses belonging and security. Peer group attachments become a source of great satisfaction. The peer group provides appropriate social roles, norms, values, and attitudes for group members, and thus factilitates group conforming patterns and a means of gaining acceptance. The adolescent reacts to the group in a manner that he/she feels will be most rewarding. And as Lombardi suggests, these efforts can take place at either the conscious or unconscious level (1963).

With peer group influence established as a viable source from which adolescents learn social behavior and attitudes, one might expect female adolescents to enhance rather than deter one another's positive affiliation with participation in educational science and attainment of

science-related careers. As cited previously female girls maintain a postive attitude toward educational science and its related activities throughout the elementary grades. It is only through intensified sex-role socialization of the female during the middle school years, with traditionally oriented parents and educators as highly influential, that the female adolescent incorporates significantly more negative attitudes toward science than males. With the influence of "peer group" isolated from associated parent and teacher sex-role socialization influences the perception by female adolescents that science is not feminine should not be derived from same-sex peers.

Although not highly investigated, available research does suggest that this is true. Studies which compare coed girls' feelings about science with those of non-coed girls find that the non-coed girls rate physical science as less masculine than the coed girls (Vockell and Lobonc, 1981). Kahle (1983) confirms that in single sex schools, in an environment where they are not socially ostracized for success in a field perceived as masculine, girls enroll and achieve in physical science and mathematics as well as in the natural sciences. In addition, the girls in this situation indicate interest in a range of scientific and technical careers.

Although the above findings are encouraging, the majority of our nation's female students participate in

coeducational classroom environments (whether public or private schools). Subsequent competition between male and female peers occurs across all academic subjects. Boys encourage successful competition in "feminine" areas such as english and literature but communicate the undesirability for females to compete successfully in physical science (Vockell and Lobonc). High achievement in science results in lower popularity and fewer male/female associations (Barnett, 1975). Further, mere dominance in the science classroom by male peers elicits "fear of success" imagery among adolescent girls (Capps, 1978). Adolescent males significantly influence the shaping of female adolescent behavior and attitude formation toward science. Peer influence however, is not limited to males.

Girls initially predisposed to positive scientific attitudes are also undermined by other female peers undergoing gender socialization. Traditionally reared female adolescents, who feel negatively toward educational science and its related activities, consciously and unconsciously alter other girls' attitudes (Lombardi). Female peers emphasize social acceptance: feminine dress, male/female relatonships, and educational achievement in literature but not in science (Hill and Lynch).

Although much data support that friendships among same-sex peers relates to the degree of similarity on a variety of attributes such as attitude, values, and

personality traits (Newcomb, 1961), Kandel (1978) reports that frequently the adolescent will modify her own behavior and attitudes rather than dissolve such peer associations. It is interesting to note that although non-coed girls rate science as "less masculine" than the coed girls, they continue to view science as far more masculine than other female-sex-typed subjects such as English (Vockell and Lobonc). This may be due to same-sex peer associations outside of the school environment (specifically with other girls who are students in coed schools).

In summary, parents, teachers, and peers represent the most significant constituent influences within the socio-cultural framework of sex-role socialization. Through gender-differential child-rearing practices and sex-role stereotyping in the classroom, female adolescents (particularly during the middle school years upon pubertal maturation) develop negative attitudes toward science and science-related activities.

Social Psychological Aspect: Self-Concept

Pressures on youth to conform to socially derived sex roles are particularly powerful in this country (Metzger, 1961). Parents, teachers and peers encourage the developing adolescent female to inhibit aggression and express dependency, passivity, and conformity. In contrast, society recognizes the male as inquisitive and assertive in

educational and social matters, aggressive, and achievement oriented. The female adolescent quite sufficiently learns (particularly during the middle school years upon pubertal maturation) that she must be feminine (Stein, 1976). Girls, who during elementary school preferred baseball to dolls, and science to English, upon adolescence understand it is time to incorporate socially accepted female traits (Hall and Lynch). Competition and success are accepted only in appropriately "feminine" areas. (And as previously discuss, educational science [and its related activities] are definitely not socially accepted within a feminine domain.)

Within the social psychological framework of the sex-role socialization process in this country, the adolescent female establishes a self-concept/self-identity as she matures (Harrington, 1970). Burton and Whiting (1961) distinguish between three such types as development advances: the attibuted, the subjective, and the optative. The attributed identity reflects those statuses assigned to the self by society. A subjective concept houses those relevant characteristics that the person himself/herself occupies. And the optative self-identity encompasses those traits that the self wishes to incorporate (p. 3). Although socialization aims to produce adults whose three identities are congruent, reports exist which are dubious toward the accomplishment of this within one's lifetime (Metzger, 1961).

The significance of this discussion however, rests on the reliability of self-concept/science studies and the determination of whether the socially derived self-image ("attributed identity") abates or propagates the postive affective orientations toward science as initially displayed by the female during the elementary years.

As might be expected, the attributed self-concept (socially accepted) developed by the female during adolescence reflects the incorporation of those social and educational experiences discussed previously. So not to re-iterate extensively, this portion of the paper simply cites that research which postively correlates self-concept to scientific achievement and interest. Whether sex-typed self-identities truly inhibit postive affective orientations toward middle school science is examined.

Self-social reactions. Most self-concept theories agree that behavior, and the responses it elicits from others, helps shape one's self-perception (Doran and Sellers, 1978). Consequently, due to the adverse social reations from parents, teachers, and peers which the early adolescent female encounters as she portrays general interest and subsequent achievement within the male domain of educational science, she develops a self-image of nonparticipant in future scientific endeavors. Although this assertion is not supported verbatum, Hill and Lynch (1983) do report that during the middle school years, when stability of any prior

self-image decreases, girls begin to see themselves as more strongly oriented toward interpersonal goals and compliancy (feminine traits) rather than achievement and independence (p. 213). [Note: As presented in "Science as a Male Domain" researchers do not identify "interpersonal interests" and "compliancy" as those traits positively correlated to participation and achievement in science and its related activities.] Further, Simmons (1979) acknowledges that during this adolescent period (ages 11 - 14) the development of a new value system by girls evolves which emphasizes socially agreed upon "female" personality traits.

Due to the overriding socio-cultural influences it is no surprise that the female adolescent's self-image strives toward a more "feminine" identity. The question still remains, however, as to whether or not a positive correlation exists between this self-concept and the inhibition of positive affections toward science.

Although literature is brief on the subject of self-concept/science studies, data suggest that a relationship does exist. Research recognizes that female self-concept is a reliable predictor of achievement and interest in science (Brookover, et.al., 1974). Doran and Sellers (1978) cite Vargo's Self Concept in Science Semantic Differential as an instrument which validly measures self-concept in science. Alvard and Glass (1974) further offer the "Self Appraisal Inventory" as a measurement scale

which provides strong potential for predicting scientific achievement from self-identification variables.

Self-concept positively correlates to scientific achievement and interest. Studies ascertain that female adolescents, who during the middle school years develop self-images reflective of sex-role socialized "feminine" types, will not retain positive attitudes toward a masculine domain such as science. As Lawrenz and Welch (1983) agree, "girls view success in science class as unfeminine; [to achieve in this field is]... an image few teenage girls would relish" (p. 660).

Self-as-student. Handley and Morse (1984) also acknowledge that positive relationships exist between middle school females' self-identification variables and scientific attitudes. The data indicate that as girls continue their studies from seventh to eighth grade, the stereotyped view of male dominance in science becomes positively correlated to female attitudes toward science. It appears that the girls continue to achieve in science (in the seventh grade) independent of these stereotyped ideas. However, as they mature in the eighth grade attitudes begin to incorporate existing social concepts of male dominance in science (p. 606). It is important to note that this supports the research presented in "Socio-Cultural Influences" which acknowledges the intensification of gender-differential socialization (due to pubertal maturation) during the middle

school years.

Expatiation upon the relationship existing between self-concept and scientific attitude intimates the topic of "female-self as science student." Brush (1979) acknowledges that the student's self-image positively correlates to science course enrollment. He further explains that if students feel they share those traits identifiable as characteristics of scientists, then it follows that these students feel more comfortable among scientists or more suited to the kind of work done by scientists.

In consideration of the preceding review of the sex-role socializaiton process through which pressures from parents, teachers, and peers (intensified during the middle school years) result in self-image development reflective of what society believes to be feminine, it is purported that female adolescents do not perceive themselves as scientists (Vockell and Lobonc). Consequently, they do not pursue the incorporation of those masculine traits associated with science and its related activities. Accoring to Brush, this indicates low enrollment in science courses and subsequent negative attitudes toward scientific activities (1979) . As referenced by Kahle et.al.(1983) such indicated outcomes are documented: females do enroll in fewer science courses than males and girls do possess significantly more negative affections for this field of study than males.

Female adolescents will retain positive affections

toward educational science and continue enrollment as students in science courses only if they perceive themselves as possessing the traits identifiable as characteristics of scientists (Doran and Sellers, 1978). The traits associated with scientists are socially recognized as masculine, however. Thus, females do not integrate them within the repetoire of perceived images established during self-concept development during the middle school years (Brookover et.al., 1974). In support of this, Main (1972) studied a group of women science teachers to identify those characteristics (in females) most obviously related to scientific activity. The resulting data communicate that female high school students perceive these teachers as less feminine than female instructors in other desciplines, possessing personality traits including touch-mindedness (versus tender-mindedness), emotional stability, and independence.

In summary, the middle adolescent female's perception of "self," as derived through social interactions, and her subsequent recognition of those traits socially identified as "scientific" (being positively correlated to "masculinity") result in an image opposite that which fosters positive scientific involvement and affection.

Cognitive Development as Related to Scientific Attitudes

Any warranted study of the factors affecting female attitude formation toward science, and the subsequent analysis of gender-differential socialization patterns in this country which influence such orientations, must entertain the possibility that gender differences in cognitive development may account for disparities between adolescent male and female affective orientations. This section investigates possible sex differences between 11 - 14 year-olds in cognitive areas of spatial visualization, operational task ability, and combinatorial reasoning to determine whether such possible gender differences positively correspond to discrepancies in attitudes toward middle school science. Finally, a review of data which suggests that the psychobiological theory and the personal-historical hypothesis account for these differences is presented.

A battery of existing literature supports the claim that cognitive differrences do exist betwen male and female adolescents (Haertel, et.al., 1981; Maccoby and Jacklin, 1974; Treagust, 1980; and Shayer and Wylam, 1978). Further, such gender differences in cognitive development result in more negative attitudes toward science by females than males (Kahle, 1983; [Walberg, 1969] Haertel, et.al., 1981; and Graybill, 1975). Finally, although controversy continues, a

large percentage of exisitng data appear to believe that the sex-role socialization process in this country accounts for the reason why female adolescents differ so in cognitive skills from their male counterparts.

Gender Differences

Maccoby and Jacklin recognize several cognitive areas in which sex differences have been documented among 11 - 15 year-old adolescents (1974). Females perform better on general I.Q. tests during pre-school and early elementary school, but males perform better in middle and high school. After age 10, although sex differences in verbal ability are not large, girls do somewhat better in grammar, spelling, and word fluency. These researchers also document gender differences in such cognitive areas of number ability, arithmetical reasoning, and spatial visualization. Males show a greater affinity for all three disciplines by approximately age 14. With respect to analytic abilities, the findings are less clear; but males seem to be somewhat higher on this cluster of traits also (1974).

Treagust (1980) states that infralogical and logical grouping abilities prerequisite any functinal knowledge of certain aspects of mathematics and spatial relations in physical science. In view of Maccoby and Jacklin's findings it is not surprising that 15 year-old males score higher on Piagetian tasks testing for development of infralogical and

logical groupings ([Doyle, 1979] Treagust). In support of this, Graybill (1975) makes reference to gender differentials evident in transition from the concrete to the formal operational stage of intellectual development. She reports that data show significant differences in logical-thinking ability at ages 11, 13, and 15. Adolescent boys average a score approximately twice as high (as girls) on such Piagetian tasks incorporating formal operational thinking.

Cognitive ability in science. Evidence concludes that middle adolescent gender differences do exist in cognitive development and subsequent cognitive abilities. But are these cognitive areas related to achievement in science? Lawson (1983) believes so. He states that the utilization of "logic" is basic to hypothesis testing in science (p. 347). Treagust (1980) reports that physical science achievement requires spatial visualization skills. Further, Reesink (in Treagust) argues that males develop better spatial abilities than females because of the type of subjects they encounter in the school curriculum (junior high school boys tend to study technical drawing, while the girls learn home economics [p.94]). Finally, Graybill proposes that boys solve select science problems (more easily than girls) because of their apparent success in transition from concrete to formal operational thought during adolescence (1975).

Combinatorial reasoning is also vital to science achievement (Hernandey, et.al., 1984). The ability of adolescent students to establish relationships between two organisms and/or populations requires combinatorial reasoning. Compound formation, as well as relating the variables in a circuit, demand such skills (p. 374). Although present studies indicate no gender difference in students' abilities to use combinatorial reasoning (Hernandez, Marek, and Renner), it is important to note that neither sex does it well.

For the purposes of this study gender differences in cognitive ability, as they relate to scientific attitudes, are the concern. For this reason, combinatorial reasoning, which presently sheds no light on this phenomenon, will hereby be dismissed. Further studies however, are recommended to examine what, if any, relationships exist between combinatorial reasoning development and operational task/spatial visualization skills in adolescents.

Relationship to scientific attitude. Kahle (1983) acknowledges that cognitive differences exist between the sexes. She cites Witkin (1977) however, saying such differences in cognitive personal traits are not extreme enough to account for the lack of entrance and success of females in educational science and the subsequent negative orientations that follow. Graybill (1975) disagrees. As adolescent girls have more difficulty in advancing from

concrete thought patterns to formal thinking abilities (necessary for achivement in science), they become less willing to actively participate in certain areas of intellectual endeavor [ie. science] (p. 345). When involved in science laboratory work adolescent girls make reference to their lack of skill and frequently ask for "permission" to perform some needed manipulation (Graybill).

Although Graybill does not specifically state that female adolescents possess more negative attitudes toward science because of gender differences in their cognitive development, she does correlate feelings of submissiveness and dependence in science, along with elicited low achievement behaviors in science activities, to the lack of sufficient cognitive development in the operational thought stage. In view of McClosky's (1976) claim that poor attitudes toward science are directly related to lower educational achievement levels, one may conclude that adolescent girls (ages 11 - 15) possess more negative attitudes toward science than their male counterparts because of gender differences evident in cognitive development.

In suppoort of this, Fishbein (1967) states that behavior is a function of attitude. Consequently, a reluctance by females adolescents to actively participate in the masculine domain of middle school science, and the exhibition of low achievement when they do participate,

reflects negative attitudes toward educational science and its related activities. (See "Science and the Socialization of Females" for further documentation.)

Cause of Gender Differences in Cognitive Development

Gender differences in cognitive development discernibly exist among middle adolescent males and females. Further, these differences account for some of the disparity between the sexes regarding scientific attitude. In light of the lengthy discussion of the sex-role socialization process in this country as a supported explanation for why females harbor such negative attitudes toward educational science and its related activities, it is important to determine here if such cognitive differences extend from psychobiological (genetic epistemological) derivatives, as suggested by Bock, et.al. (Treagust, 1980), and Maccoby and Jacklin (1974), or whether such differences are again due to gender differentiated personal-historical experiences (sex-role socialization) as believed by Hernandez, Marek, and Renner (1984), and Skolnick (Kahle, 1983). Debate at this time persists concerning which hypothesis best explains the above mentioned cognitive differences.

Although Treagust (1980) suggests that the gender differences apparent in cognitive development can be individually accounted for by the personal-historical perspective, Maccoby and Jacklin believe a genetic epistemological explanation better delineates such

occurrences. Maccoby and Jacklin (1974) contend that the consistency of gender differences on tasks presented to adolescents, and the lack of gender differences in elementary school subjects, warrants strong consideration that a genetic epistemological explanation better accounts for the data. Bock and Kolakowsky ([1973; and Buffery and Gray, 1972] Treagust) agree with these gentlemen, citing evidence of a sex-linked gene that contributes an element to high spatial ability.

The genetic epistemology advocators warrant respect for their research findings. Considering the timetable referenced by Maccoby and Jacklin , however, one may feel this supports the sex-role socialization process theory. As previously indicated, general overall sex differences relating to attitudes toward science (the formation of which has been explained through sex-role socialization) frequently do not appear significant until the middle school years.

Hernandez, et.al. (1984) further justify this assertion via their study of Relationships Among Gender, Age, and Intellectual Development. These investigators report that an important factor involved in differentiation of the sexes and cognitive development (specifically, operatonal reasoning) is "experience" (p. 373). Kahle (1983) cites Skolnick's claim that increased experience with manipulative materials such as constructing and examining

three-dimensional structures, graphing, and modeling of experiments by males in the science classroom are critical to the advanced development of their cognitive skills (spatial visualization skills). Finally, Piaget repudiates Bock and Kolakowsky's report. Piaget states that representational spatial development is not enhanced by any hereditary link (1971).

Controversy continues as the question of whether the gender differences which exist in cognitive development are due to psychobiological derivatives or personal-historical experiences. From the present review however, a large percentage of existing data appears to support the sex-role socialization process as a reputable explanation as to why female adolescents differ in cognitive skills from their male counterparts.

Science and Attitude Change/Formation Theories

In past years most research studies concentrated on establishing the fact that during the middle school years female adolescents develop significantly more negative attitudes toward science and its related activities than their male counterparts. Further explanations focused on the social, educational, and personal factors which suggested why such affective orientations originated and continued to persist. Parent and peer, as well as educational administrator and teacher influence (under the auspices of the socio-cultural framework of sex-role socialization in this country) have been highly stressed. Concurrently, research on the female's self-image developed during middle adolescence (as derived from the social psychological influence of gender-differential socializaiton) has been intimated. The personal factor of cognitive development has also been correlated to gender differences in scientific attitudes.

While review of the above factors provides insight into <u>why</u> female adolescents possess negative attitudes toward science, it offers little implication for <u>how</u> such orientations are facilitated. For example, when a female adolescent incorporates a "feminine" self-image, what psychological process is in operation which elicits this emotional disposition?

Understanding the sex-role socialization pattern in

this country provides powerful means by which to comprehend why middle adolescent females develop negative attitudes toward science. The scope of such a phenomenon, however, requires further explanation. This study proposes that attitude change/formation theories account for "how" the sex-role socialization of females produces such negative scientific affections.

Although research examines male/female science teachers as possible modeling agents effective in influencing female scientific attitude formation, little explanation is given which explains "how" the theory of modeling operates. The same neglect holds true for authors who refer to "psychological discomfort" and "rewards systems." In addition to the grave infrequency with which such factors are even mentioned, researchers omit any explanation of how Cognitive Dissonance and Operant Conditioning theories (respectively) function within the socialization process.

Due to the need for further understanding of female negative affective orientations toward science as pre-emptive to enhancing improvement of such attitudes, this paper investigates the dynamics of specific attitude change/formation theories synergistic to the sex-role socialization process. Concurrent with the social, educational, and personal aspects of female development these theories operate under the auspices of the socio-cultural and social psychological framework. Upon a

brief overview of the specifics of each theory and possible existing relationships to female scientific attitude formation, delineation of the theory constructs will be presented.

Delineation of Theories

This paper examines four attitude change/formation theories to explain how female students begin elementary school positively oriented toward educational science and its related activities, yet graduate from high school harboring significantly more negative attitudes toward this field than their male counterparts. The theories which suggest such correlations are: Festinger's Theory of Cognitive Dissonance, Bandura's Theory of Modeling, Bem's Theory of Self-Perception, and Skinner's Theory of Operant Conditioning (Contingent Reinforcement Principle).

Festinger's Theory of Cognitive Dissonance states that a tension is produced in the mind of the individual which causes an emotional disequilibrium (Bem, 1970). Regarding the female adolescent in elementary school, she initially possesses positive attitudes toward science. I propose that through continued association with peers, teachers, and parents, however, by middle adolescence significant tension (or psychological discomfort) may result in her mind which causes the girl to feel emotionally confused about her positive attitudes toward science. To relieve this emotional disequilibrium, then, the female adolescent may re-examine

her disposition and make an attitudinal change which positively corresponds to that which the sex-role socializaiton process endorses.

Bandura reports attitudes are "learned" through the socialization process. More specifically, the Theory of Modeling incorporates the technique of learning by observation (Zimbardo, et.al., 1977). The individual observed (the model) provides precedent for the observer's behavior and subsequent attitude formation. The ability to influence another comes from the fact that the model "informs" the observer about something of importance. This process of enlightenment elicits respect and admiration from the observer. I propose that the female adolescent identifies her model, respects the forthcoming opinions regarding scientific attitudes, and subsequently imitates the behavior of the model. As sex-role socialization ensures, adolescent females learn through available models that participation and achievement in science is unacceptable (non-feminine) and thus behaves accordingly.

Although Bandura doesn't specifically state that learned behavior through modeling incorporates new attitudes, Bem's Theory of Self-Perception may account for this. Bem argues that attitudes are not reflections of what an individual is predisposed to do, but rather leftover vestiges of what he/she is doing or once did. Behavior influences the development of attitudes and other internal

states because a person infers the latter from observations of his/her overt behavior and the context in which it occurs (Bem, 1972). Consequently, Bem's Theory of Self-Perception may account for how such questionaire responses (by female adolescents) as "I dislike science," or "I do not feel successful in science class" are derived. As the female adolescent reviews her sex-typed behavioral experiences (as nonparticipant in science activities) she may infer that she feels adversely toward science. The female uses her own behavior and the situation in which it occurs to make attritions about what she is feeling.

The fourth attitude change/formation theory which this paper examines as a possible explanation of how negative attitudes toward science by female adolescents evolve is Skinner's Theory of Operant Conditioning (Contingent Reinforcement Principle). This theory relies on the administration of appropriate rewards and the effects of such external stimuli on attitudinal and behavioral change (Zimbardo, et.al., 1977). Formation of the female's negative orientation toward science then, may depend on the positive and negative reinforcers she receives through gender-differential socialization. Consequently, the girls develop negative attitudes toward middle school science possibly because they perceive parent, peer, and teacher feedback regarding their withdrawal from educational science experiences as positive reinforcement for feminine,

sex-typed roles.

In the preceeding paragraphs this paper breifly overviews each of the considered attitudinal change/formation theories which operate synergistically with sex-role socialization of the female adolescent. As a possible explanation for "how" females integrate negative attitudes toward educational science, it is now important to review exising literature for delineation of specific constructs. Establishment of possible relationships to negative scientific attitude formation will then follow. (Note: It is important to remember that the above referenced relatioships between attitude formation theories and female negative scientific attitude are simply "implications" at this point. Section "Relationship to Female Scientific Attitude Formation" cites specific sources which support or deny such associations.)

Cognitive dissonance. The formation or change of one's attitudes relies on the acquisition and integration of knowledge (Shrigley, 1983). If this information is consistent with an individual's present beliefs and behaviors, his/her attitudinal orienation is reinforced. If however, this information is inconsistent with present attitudes, or if discrepancies exist among multiple pieces of incoming information, the individual experiences psychological tension (Festinger, 1957). As Festinger's Theory of Cognitive Dissonance acknowledges, tension thus

produced in the mind of the individual causes emotional disequilibrium (Bem, 1970) and subsequent change of attitude.

Further understanding of Festinger's Cognitive Dissonance Theory is possible by examining his previous works on social comparison (Festinger, 1954). People need to compare themselves to others in order to evaluate their own abilities and opinions. Because there is no objective standard against which to evaluate attitudes, an individual compares himself/herself to a social reference group to discover whether his/her affective orientation is justifiable, valid, and rational. To the extent that a discrepancy exists between one's initial position and the norm of the reference group, the person possesses a "need" to reduce the discrepancy by either changing one's position in the direction of the norm, trying to influence the group norm, or rejecting the group as irrelevant (Zimbardo, et.al., p. 65).

The idea that individuals can not tolerate discrepancy between their own and others' attitudes provides the foundation upon which the Cognitive Dissonance Theory rests. Festinger (1957) retains the notion that discrepancies or inconsistencies cause an uncomfortable tension that people try to reduce or eliminate. Shrigley (1983) as well, acknowledges that if the message to a recipient involves two cognitions, two inconsistent pieces of information held

simultaneously that result in dissonance, a psychological discomfort ensues (p. 426).

It is important to understand what "cognitions," or "cognitive elements" intimate. Cognitions or cognitive elements are bits of knowledge ("it is raining"), opinions ("I like the rain"), or beliefs ("the rain makes flowers grow") either about the environment or about oneself (Zimbardo, et.al.). Cognitive elements integrate an individual's behavior with the environment. This implies that change in the environment and in the person's behavior may produce changes in the person's cognitive elements (p. 67). Snyder and Ebbesen (1972) confirm this within the realm of Cognitive Dissonant explanations. If societal pressures induce an individual to behave contrary to his/her beliefs, the person tends to change these beliefs so that they become more consistent with his/her behavior.

In correlating attitude change/formation theories to the facilitation of sex-role socialization of adolescent females it is important to investigate the predictive power of Festinger's theory. The final dimension of the Cognitive Dissonant Theory examined includes those factors affecting the magnitude of dissonance between situations (Zimbardo, et.al.). For example, simply because a female adolescent recognizes inconsistencies between her behavior toward science and that of social norms regarding this behavior what guarantees that emotional dissonance results?

First, the relative "importance" (p. 67) of the existing inconsistency will determine how disequilibrated (emotionally) an individual feels. As sherif and Sherif agree (1967) the "importance" or "relevance" (p. 134) of the matter at hand determines the degree of personal/emotional involvement. The more important the individual considers the situation, the more dissonance results from inconsistencies. Second, the "number" (Zimbardo, et.al., p. 67) of dissonant or consonant cognitions existing at one time will determine the magnitude of dissonance an individual experiences. More specifically, the greater the ratio of dissonant to consonant elements, the greater the amount of dissonance that the individual incorporates (mentally). The third factor affecting the magnitude of psychological discomfort and subsequent degree of attitudinal change is "cognitive overlay" (p. 68). This refers to the functional alternatives represented by each cognition. Specifically, if the alternatives available (by which the individual may reduce the inconsistences and subsequent emotional tension) have much in common, then the dissonance aroused by the decision between alternatives is minimal. Conversely, if the alternatives have less in common, the dissonance is greater (Zimbardo et.al., 1977).

Summarily, Festinger's Theory of Cognitive Dissonance provides predictive and explanatory power of how the sex-role socialization of female adolescents may facilitate

the formation of negative attitudes toward middle school science and its related activities. Such correlations are researched later in "Relationship to Female Scientific Attitude Formation."

Modeling. As Festinger supports, Bandura also believes that attitudes are learned through socialization (Bandura, 1973). Attitudes imply a relationship between persons. As Sherif and Sherif acknowledge (1967), attitudes "are learned" in relation to identifiable referents - be they persons or groups of persons (p. 112). The Theory of Modeling specifically recognizes that learning attitudes results from learning socially derived behaviors. Zimbardo et.al. suggest that the technique of applicability via which this social learning evolves utilizes repeated "observations" of models which inform an individual of acceptable social behaviors (1977). The person observed (the model) provides precedent for the observer's behavior and subsequent attitude formation (Zimbardo, et.al.; and Bem, 1972). The ability to influence another comes from the fact that the model "informs" the observer about appropriateness of action. This process elicits respect and admiration from the observer resulting in imitative behavior and subsequent integration of similar attitudes.

(Note: Due to the nature of Bandura's Theory of Modeling which relies on "observation" for learning (learning by example), examination of the characteristics of

this theory necessarily focuses on behavior - observable behavior. Based on Fishbein's conclusion that "behavior is a function of attitude" (1967), the subsequent relationship between imitative behavior and affective orientation will also be investigated.)

To understand how modeling may facilitate the sex-role socialization process of female attitude formation toward science the properties of the theory require delineation. "Learning by example" (or more specifically, shaping one's attitudes as respondent to observed behavior), depends on four interrelated subprocesses: attention, retention, motor reproduction, and reinforcement (Bandura, 1973). These subsystems govern observation learning; they specify the conditions that must be met if examples set by others are to have enduring behavioral (and attitudinal) effects.

A person cannot learn by observation if he does not attend to, or recognize, the important features of the model's behavior. Thus, one of the main component functions in observational learning involves attentional processes (Bandura). As Bandura suggests (1973), mere exposure to a model does not in itself ensure imitation. Zimbardo, et.al. (1977) confirm this. They acknowledge that the individual observer possesses an option to imitate or ignore the model. Models must elicit attention through efficacity. In other words, the individual observed must be effective in stimulating and dircting the appropriateness of the

observer's responses so that specific learned behavior is valued by the imitator. Models (as sources of behavior) must incorporate an utilitarian value within their behavior to warrant attention by perspective observers. Consequently, the behavior of models who possess high status in presige, power, and competence hierarchies command greater attention than those who do not (Bandura, p. 70).

It is important to note here that no matter how successful a particular model is in eliciting attention for specific behaviors, little imitative response occurs (and endures) because of one single person. As Sherif and Sherif (1967) suggest, attitudes are seldom acquired or changed in situations involving only the individual and one single communicator (model). Although traditional theories of personality depict strong identification of a child with one other individual predetermining the direction of later development, research findings reveal that modeling influences are considerably more complicated (Bandura). Modeling is a continuous process in which new behaviors (and subsequent attitudes) are acquired, and existing patterns to some extent modified, by exposure to influences from diverse models at all periods of life (p. 70).

The second subsystem that accounts for possible imitability and endurance of observable behavior is retention (1973). The observer must remember the modeled behavior if he/she is to imitate it. Bandura suggests that

in order for an individual to reproduce social behavior when the model is no longer present to serve as a guide, the response patterns must be represented in memory in symbolic form. Past events achieve permanence by being represented in images and in descriptive verbal symbols for future use (p. 71). Consequently, these memory codes serve as internal guidelines for imitative behavior of retained observations (Bandura).

Once the "attentive" and "retentive" subprocesses have been experienced by the observer, he/she must physically enact the example behavior to further incorporate the attitudes implicit in such actions. As Bandura recommends (1973), this is the third component of modeling: motor reproduction. Behavioral reproduction conditions the learned response and subsequent affective association. As will be discussed shortly, without behavioral re-enactment of such modeled behavior, the individual lacks sufficient inferential ability regarding delineation of internal states (attitudes) which observations of overt behavior elicit (Bem).

Finally, reinforcement and motivational subprocesses (the fourth component of the theory of Modeling) warrant consideration. An individual may acquire, retain and possess the capabilities for skillful execution of modeled behavior, but without social reinforcement and encouragement rare displays of such overt performances prevail (Bandura).

Reinforcement not only regulates the expression of matching behavior, but also affects observational learning by determining the amount of attention an individual pays to various models. Incentives aid selective retention of what has been learned by motivating the observer to code and rehearse those modeled responses that have high functional values for him/her (p. 72).

In summary, the role that "modeling influences" plays in the facilitation of sex-role socialization of middle adolescent females and the resulting incorporation of negative attitudes toward science appears promising. Further explanation regarding reinforcement and whether such associations actually exist is presented in "Operant conditioning."

Self-perception. Determination of whether the Theory of Self-Perception accounts for "how" the behavioral socialization of females in this country factilitates the incorporation of negative affective orientations toward science requires delineation of the theory first. Specifically, Bem's theory sheds light on the existing paradigm - behavior as a function of attitude /or attitude as a function of behavior.

Fishbein (1967) believes behavior is a function of attitude; Bem suggests attitudes are inferred from behavior (1970). Examination of Bandura's research (1973) leads one to consider that Bem is correct. As implied by the theory of

Modeling (above) motor reproduction (or behavioral enactment) of modeled behavior supplies sufficient inferential ability regarding delineation of internal states (attitudes) which observations of overt behavior elicit. Although this paper realizes that some researchers protest, saying the the question is merely academic "which came first - the behavior or the attitude?' (the chicken or the egg?), it is important to consider this issue for the purpose of establishing later associations between sex-role socialization and the facilitation of female scientific attitudes.

Bem's Theory of Self-Perception argues that attitudes are not reflections of what an individual is predisposed to do, but rather leftover vestiges of what he/she is doing or once did. Behavior influences the development of attitudes and other internal states because an individual infers the latter from observations of his/her overt behavior and the context in which it occurs (Bem, 1972). As Zimbardo, et.al. (1977) confer, the individual uses his/her own behavior and the situation in which the behavior occurs to make attritions about what he/she is feeling (as well as why he/she is feeling that way).

Bem's analysis of <u>self-persuasion</u> provides the basis for his interpretations above (1965). In earlier research he concludes that self-descriptive statements known as beliefs and attitudes are often under the influence of the

individual's overt behavior and its apparent controlling variables. Since public stimuli and responses are those which the socializing community itself must use initially in training the individual to "know himself," the individual's belief and attitude statements are functionally equivalent to those that an outside observer would attribute to him. They are "inferences" from the same evidence (p. 217). As Bem continues to support this in later research (1972), he recognizes that:

> ...To the extent that internal cues are weak, ambiguous, or uninterpretable, the individual is functionally in the same position as an outside observer, an observer who must necessarily rely upon cues [overt behaviors] to infer the individual's inner states (p. 2).

Another important aspect of Bem's Self-Perception Theory is his treatment of dissonance (as cited by Festinger) which individuals experience when behavior and attitudes (or two co-existing internal states) clash. Bem rejects the dissonance postulate of an adversive motivational state (Jones et.al., 1968). He proposes instead that individuals "discover" what their real attitudes are by discriminating between the apparent controlling circumstances of their behavior (p. 248). Similarly, suggests that the person is an observer of his own behavior,

and the crucial consideration is whether the person sees his discrepant behavior as having been called forth by some specified reinforcement contingency in the external environment (1968). Thus, if the person sees his behavior as having been performed to obtain a large reward, he infers that his true attitudes do not necessarily reflect his behavior. The smaller the reward offered, the more likely the subject to infer that his attitudes truly reflect his behavior (Zimbardo, et.al.).

In a more recent study, Snyder and Ebbesen (1972) outline conclusive data regarding attitudes as self-judgements. They support that self-perception is the inference of attitudes from one's behavior. In an extended study of forced compliance experiments (such as that discussed by Jones et.al. above) however, Snyder and Ebbesen delve into the relationship between dissonance and the Self-Perception Theory to uncover explicitly the treatment of the prior by the latter. They suggests that it is possible that the present negative relationship between perceived discrepancy and attitudes will occur only when a subject believes himself/herself to be a low credibility communicator (p. 515). In effect, Snyder and Ebbesen are recommending that complex variables such as how the subject views his/her own behavior, how he/she views the situation in which this behavior occurs, and how he/she views his present and past attitude positions all contribute to

his/her inferential abilities (1972). The complexity of such studies demonstrate that prior conceptions of self-judgement theories (such as Bem's Theory of Self-Perception) may be too simplistic in their interpretations.

Although Snyder and Ebbesen's dramatic conclusions warrant consideration, the scope of this paper does not include diagrammatic examination of Bem's Self-Perception Theory. This paper however, will utilize sufficiently supported properties of the theory which may correlate to the facilitation of middle adolescent female scientific attitude formation under the influence of sex-role socialization patterns in this country.

Operant conditioning. Throughout the preceeding paragraphs subtle, yet significant, reference has been made to Skinner's Theory of Operant Conditioning. As an extension of social comparison the Theory of Cognitive Dissonance suggests that behavioral and attitudinal change occurs because one is motivated by various socially based needs - the need to compare oneself to others, the need to evaluate one's own abilities and attitudes, and the need to reduce or elimiante discrepancies between one's own position and social norms. Essential to this process is the power of society to reward a member for compliance and punish for deviance in any given situation (Zimbardo, et.al., p. 66).

Discussion of Bem's Self-Perception Theory and Bandura's Theory of Modeling also included reference to the

situation (environment) in which an individual's behavior and subsequent attitude occurs. The situation may include specific "reinforcement contingencies" by the external environement (See Section on "Self-perception") and/or social "reinforcement" and motivational encouragement (See Section "Modeling). Bem further states that ... public stimuli and responses are those which the socializing community (and individual) use to "know oneself".

With such consistencies established, rewards/contingent reinforcements must be investigated as possible facilitators of the sex-role socialization of females and the subsequent formation of negative scientific attitudes that result. Specifically, Skinner's Theory of Operant Conditioning [Contingent Reinforcement Principle], as applicable to behavior modification and subsequent attitudinal change, relies on the administration of appropriate rewards and the effects of such external stimuli on attitudinal and behavioral dispositions (Zimbardo, et.al., 1977).

Operant conditioning applies to any situation in which behavior (and subsequent attitude) is modified because of the administration of positive or negative reinforces (Pitts, 1971). Before discussing specific methods of reinforced conditions however, it is important to examine specifically what the "contingent reinforcement principle" entails. (Note: "Subsequent attitude" is included not because of an explicit statement of association by Skinner,

but because of established correlations to behavior as cited by Fishbein, Bem, Norman, Kahle, and Zimbardo.)

As Platt explains (1973) three basic terms represent Skinner's Operant Conditioning Theory: stimulus - behavior - reinforcement. Platt further symbolizes this relatioship as:

$$\overset{B}{\ldots S} \quad \overset{B}{R \ldots . S} \quad \overset{B}{R \ldots . S} \quad R \ldots \text{ (p.24).}$$

The lower line in each three-term unit represents the environment's actions on the individual, and the upper line represents the person's actions on the environment. As Zimbardo, et.al. note (1977) the environmental factors acting on the individual refer to either the actual physical environment, or the presence of other people in the environment.

Platt explains that "S" is the preliminary stimulus or situation, "B" is some behavior the organism may show, and "R" is any change or "reinforcement" that is "immediate" and "contingent" on particular behavior (1973). Any behavior exhibited by the person is called an "operant," and when this is induced regularly under a given stimulus and response the process is called "operant conditioning" (p. 25). Any response that is followed by an increase in the probability of some specific behavior is a positive reinforcer. Similarly, if the probability of a specific behavior decreases consistently after a specific response from the environment, then this response is called

a negative reinforcer (Platt, 1973). It is important to note here, that the effectiveness of a reinforcer (positive or negative) depends on the presentation of it following appropriately increased or decreased behavior (respectively).

In reference to specific methods of reinforced situations, Pitts acknowledges four possible techniques for changing undesirable behavior: extinction, withdrawal and re-presentation of reinforcers, negative reinforcement coupled with positive reinforcement, and finally extinction and multiple reinforcement (1971).

Extinction is the process of behavioral modification brought about by non-reinforcement. Instead of negative consequences such as punishment, extinction is a condition of neutral consequences (Pitts, 1971). Previously reinforced behavior is no longer reinforced. Conversely, the second technique acknowledged by Pitts suggests that the presentation or withdrawal of the reinforcing condition may be contingent upon the kind of behavior engaged in. In other words, when a reinforcer has been found, presentation of that reinforcer may be made contingent upon cessation of the undesirable behavior, or, withdrawal of the reinforcer can be a consequence of the onset of undesirable behavior (p. 137).

A frequent and effective technique of behavioral-attitudinal change/formation utilizes Pitts'

third example. Initially, a negative reinforcer in the form of a warning is presented. The administrator of the reinforcers then couples this warning with a positive reinforcer. Thus, the individual avoids behaving in an unacceptable manner and is further rewarded for such appropriateness (Nielsen, 1982). Pitts' fourth technique also involves coupling, but in this case extinction procedures are employed first, followed by multiple positive reinforcers (pp. 138-139).

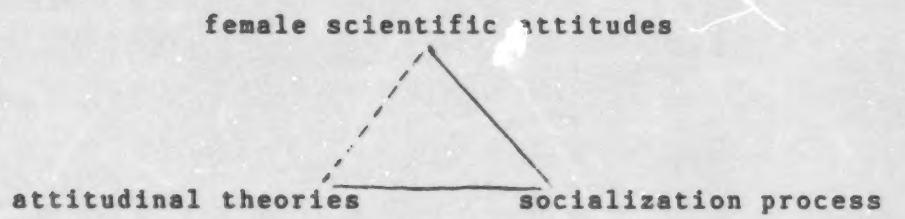
In summary, whether Skinner's Operant Conditioning Theory accounts for facilitation of sex-role socialization and subsequent formation by females of negative scientific attitudes, depends on the theory's ability to sufficiently identify positive and negative reinforcers within the socialization process. This appears possible in consideration of Skinner's recommendation that we look to the "culture/social environment" in which a person's behavior will be a function for further understanding of modifications of such behavior ([Skinner, Answers For My Critics] Platt, 1973).

(Note: Although this paper stated earlier that Skinner makes no explicit claim of association between behavior and subsequent attitude formation, Platt does acknowledge that recent Skinnerian-type experiments show, in essence, that "changed attitudes follow or accompany changed behavior" [p. 31].)

Relationship to Female Scientific Attitude Formation

As reviewed earlier the sex-role socialization process in this country appears to account for "why" middle adolescent females harbor significantly more negative attitudes toward science than their male counterparts. "How" these patterns facilitate such affective orientations, however, is unclear. This paper proposes that four specific attitude change/formation theories best explain this phenomenon. With Festinger's Theory of Cognitive Dissonance, Bandura's Theory of Modeling, Bem's Theory of Self-Perception, and Skinner's Theory of Operant conditioning delineated in the previous sections, it is now time to investigate whether existing literature supports these theories as vehicles by which sex-role socialization produces negative female scientific attitudes.

Many available studies neglect direct and extended correlation of attitude change/formation theories to female scientific attitudes. Researchers do occasionally reference components of these theories however, when discussing sex-role socialization processes and the formation of such affective orientations. Due to this predicament, frequently the associations cited between attitude change/formation theories and female attitude development toward science are to be established "triangularly:"



In other words, this section examines those aspects of the attitude change/formation theories which socialization studies reference as explanatory processes involved in female development of scientifc attitudes. With the establishment of attitudinal theories as synergistic to the sex-role socialization process, implications for correlations to female affective orientations (toward science) will be acknowledged. In addition, analysis and interpretation of recently gathered data presented in Chapter III will determine if such relationships exist, and if so, are significant.

The following paragraphs examine four questions. They are: (1) Does psychological discomfort result because of social pressures within the science classroom? and if so - does such emotional unpleasantness facilitate an attitudinal change toward science? (2) Are modeling agents acknowledged as possible facilitators of attitude formation within the sex-role socialization explanation for female scientific attitude development? If so - how do they facilitate attitude formation? (3) Does an adolescent female's perception of her own behavior within the realm of science-related activities influence her attitude formation

toward science? and (4) What reinforcement procedures (if any) are recognized within the sex-role socialization of females which may facilitate continuous or discontinuous behavior regarding science and subsequent scientific attitudes?

Psychological discomfort. As previously stated the elementary school female student initially possesses positive affections for educational science and its related activities. Upon graduation from high school however, this same female adolescent harbors very negative attitudes toward science. As the socialization process implied, I propose that continued association with peers, teachers, and parents results in significant tension (or psychological discomfort) for the female adolescent regarding her scientific attitudes. She is confused and in a state of emotional disequilibrium (Brookover). The female adolescent feels unsuccessful and "stupid" in class (Kahle, 1983), yet simultaneously believes that science is important (Hill and Lynch, 1983). Although certain studies imply such a relationship between psychological discomfort and scientific attitude change, does literature support the assumption that psychological discomfort results from social pressures within the science classroom. Further, does literature directly relate attitude change toward science to such emotional tensions

Vockell and Lobonc (1981) and Capps et.al. (1978),

citing studies of sex-role stereotyping in science classrooms, do report that "unpleasantness" and "fear of success" (pp. 211 and 210, respectively) are emotional experiences incorporated by adolescent females as they participate in science. Further, these authors state that such imagery among females results from societal pressure against female involvement in science. Although direct correlation is not drawn between Cognitive Dissonance (psychological discomfort) and the change of attitude to a negative orientation toward science, Festinger's theory warrants applicability.

Festinger (1957) acknowledges that psychological tension results when one experiences discrepancies between incoming information and that information presently possessed by the individual. Further, because attitudes are not visibly measurable, the individual compares himself/herself to socially accepted dispositions. Citing the above proposal, the young female adolescent (strongly oriented toward change [Sherif and Sherif, 1964], and struggling for social identification and acceptance [Thornburg; Hill and Lynch; and Stein]) compares her positive attitude toward science to that information she receives from peers, teachers, and parents concerning socially-acceptable sex-typed "female" attitudes. She experiences "unpleasantness" and "fear of success" as manifestations of the inconsistency between cognitions.

The female adolescent is under emotional duress as she is socially accepted for low achievement, in lieu of the fact that she believes science to be very important (Kahle; Hill and Lynch). Conflicting cognitive elements thus propagate emotional tension (Zimbardo).The resulting change in attitude from positive affection (for science) to negative is due to the need of the individual to reduce this discrepancy (Festinger, 1954).

It is important to remember that the above mentioned relationship is not explicitly stated. However, Vockell and Lobonc's reference to such psychological discomforts as "unpleasantness" and "fear of success," and further reference to socialization processes (by Sherif and Sherif, and Thornburg, and Hill and Lynch, etc.) make such associations highly plausible.

Modeling agents. Recent studies of the sex-role socialization process do refer to the significance of role-models (modeling agents) to clarify how sex-typed behavior is learned (Raskin and Israel, 1981). Since Fishbein (1967), Platt (1973), and Norman (1975) support the belief that behavior reflects attitudinal disposition, this paper acknowledges that modeling agents facilitate female-typed attitude formation. Although Raskin and Israel do not verify specific correlations between role-models and scientific attitudes, the presentation of such attitudes as "sex-typed" via the socialization process stipulates the

association (See "Science as a Male Domain" and "Science and the Socialization of Females").

Consequently, this paper proposes that the female adolescent identifies her model, respects the forthcoming opinions regarding scientific attitudes, and subsequently imitates the behavior of the modeling agent. As sex-role socialization ensures, the adolescent female learns through available social agents that participation and achievement in science is "unfeminine" and thus, behaves accordingly (See "Science and Attitude Change/Formation Theories;" Hill and Lynch, 1983; Fox, 1980). Bandura further explains that the modeled behavior is acquired, retained, and enacted because the observed individual provides social precedence for the observer (1973).

To understand the implications modeling has on scientific attitude formation the modeling agent (the individual observed and imitated) must be examined. Towse (1983) refers to the science teacher as a recognized model highly influential in the formation of girls' attitudes toward science. Further, negative female scientific attitudes ensue because of insufficient numbers of female science teachers as models (Maccoby and Jacklin, 1974). Consequently, if female adolescents engage in science activities simulated by a female science instructor the results should be increased affections for science (as modeled by the teacher). Fryear and Thelen (1969) however,

report this is not so. Their data suggest that same-sex imitation results only when this behavior is perceived as sex-role appropriate by the observer (Raskin and Israel, p. 1068). As Main reports (1972) female science teachers are perceived (by female students) as having less feminine qualities than female instructors in other disciplines (1972). Consequently, in search of a "feminine identity" female adolescents view the female modeling agent in science as inappropriate, and thus "unimportant" in their strive for establishment of socially acceptable feminine self-images (Denmark and Goodfield, 1978).

In summary, researchers do more than just "imply" that Bandura's Theory of Modeling correlates to female scientific attitude formation. Literature supports this acclamation. Studies suggest, however that the sex of the modeling agent is less of a cue for female adolescents than the sex-role appropriateness of the observed behavior.

Perception of behavior. Bem's Theory of Self-Perception implies that the female adolescent responds to scientific attitude questionaires with "I dislike science" and "I do not feel successful in science class" because she infers from her present behavior that this is the case. As previously explained, behavior influences the development of attitudes and other internal states when a person infers the latter from observation of his/her overt behavior and the context in which it occurs (Bem, 1972). Does present

literature however, support direct association between negative scientific attitude formation and inferrence of one's behavior?

Unfortunately, however, there is not sufficient evidence to date which proves or disproves the implication that the female adolescent develops negative attitudes toward science because she infers this to be so from the observation of her overt behavior regarding science. Research does suggest however, that such assertions are possible. First, Snyder and Ebbesen (1972) report that Bem's Theory of Self-Perception relies on the "extent to which information from internal cues is weak, ambiguous or uninterpretable" (p. 504). As previously cited, the female adolescent experiences conflicting cognitive elements which also result in emotional confusion (Bem, 1972). Second, Sherif and Sherif (1964) acknowledge that middle adolescence is a period of "great psychological development and change" which elicits confusion in interpretation of feelings and beliefs (p. 181). And third, females behave adversely toward science; they exhibit dependency, underachieve, and maintain low expectancy for future attainment of scientific careers (Capps et.al.; Kahle; and Vockell and Lobonc).

Consequently, the adolescent views her behavior, feels confused about her feelings regarding such behavior and the context to which it refers, and subsequently "infers" that she must dislike science because her behavior indicates such

is the case. Bem's Theory of Self-Perception permits the female adolescent to interprete her attitudinal disposition via observation of her behavior.

Doran and Sellers (1978) add that one's behavior, and the responses is elicits from others, helps to shape one's self-perception (self-image). Further, Doran and Sellers specifically relate female adolescent behavior to her resultant scientific affective orientation. These authors however, do not explicitly reference the development of such self-conceptions as an outcome of personal "inference" by the adolescent herself.

In summary, supportive evidence suggests that Bem's Theory of Self-Perception quite possibly accounts for "how" such middle adolescent female negative scientific attitudes form. Data analyzed and interpreted in Chapter XII will determine if such positive relationships actually exist.

Reinforcement. Whether Skinner's Theory of Operant Condiioning (Contingent Reinforcement Principle) accounts for facilitation of sex-role socialization, and subsequent fomation of negative scientific attitudes by female adolescents, depends on the theory's ability to identify positive and negative contingent reinforcers. Platt confirms the importance of reinforcers when he states that an individual builds up numerous types of complex behavioral responses as he/she experiences a sequence of natural and social reinforcement contingencies (1983, p. 28). Further,

the development of attitudes accompanies the establishment of such learned behaviors (p. 38). Literature must exist then, which positively relates identified social reinforcers to the development of female scientific affections. In other words, does the female adolescent develop negative attitudes toward middle school science because she perceives parent, peer and teacher reactions toward her withdrawal from educational science experiences as positive reinforcment for such behavior?

Fox, et.al. (1983) report that specific adverse teacher and parent reactions toward eighth and ninth grade female adolescents who participated in advanced science classes resulted in the girls' low achievement and subsequent withdrawal from the courses. Kahle further notes that "lack of encouragement" toward female adolescents by parents and teachers (due to their low expectations for these girls in science-related activities) results in negative affections for science (1983). Hill and Lynch (1983) also recognize that "social ostracization" leads to female dismissal of such science-related characteristics as assertiveness and competitiveness. Byerly summarizes by reporting that affect and affective dispositions (reflective in social influences) greatly determine female consonance or discord in science and its related activities (1984).

Although the above influences are not specifically termed positive or negative "reinforcers," are they

contingent, and do they represent incorporation of Skinner's Theory of Operant Conditioning? Literature supporting sex-role socialization of females (and subsequent formation of negative scientific attitudes) does not explicitly state the incorporation of Skinner's theory as "operant conditioning' per se. The examples cited above do incorporate the idea of contingent influences within their explanations, however. Fox et.al. (1983) state that adverse reactions by teachers and parents are not indiscriminately imposed on adolescent females, but rather they result in response to particular behaviors exhibited by the girls. Previously cited literature confirms that middle adolescent girls behave adversely toward science when parents and teachers react negatively to their achievement in advanced science classes (See "Science and the Socialization of Females"). Upon re-enrollment in lower level courses the girls experience acceptance - teachers encourage them to participate and discuss points of interest in class (Fox, 19834).

The above review assumes parent and teacher response to female adolescent scientific achievement serves as a negative reinforcer. Subsequent behavior (and attitude) is modified, followed by teacher positive reinforcement. As recognized by Pitts (1971), this procedure represents one of the techniques for behavior and attitude modification identified by the Contingent Reinforcement theory (See

"Science and Attitude Change/Formation Theories").

It is important to note that the above relationship (between operant conditioning and negative scientific attitude formation by female adolescents) is triangular. Fox's research correlates contingent social influences to the socialization of females; however, only through the association of sex-role socialization and subsequent negative scientific attitude formation by female adolescents is the connection to Skinner's Contingent Reinforcement Principle solidified.

In summary many of the associations stated throughout this section result from juxtaposition. Research merely implies many of the relationships. The situations are propositional in nature. Data analysis and interpretation in Chapter III will warrant whether such proposals are to be retained or rejected.

CHAPTER III

RESEARCH METHODOLOGY

Thurstone (1928), Likert (1932), Oppenheim (1966), and Munby (1983) acknowledge that attitudes can be measured. In fact, Munby has recently published a compilation of reliable and valid instruments which measure scientific attitudes of males/female/elementary age students/high school students, etc. (1983). This study, however, does not wish to measure female middle adolescent scientific attitude per se, but rather possible relationships between this orientation and specific attitude change/formation theories. An instrument for this purpose must be developed.

The following section describes the use of the "questionaire" as a data collection device for educational research and includes a rationale for its appropriateness in this study. Distribution procedures, sample information, data results, and analyses are also presented.

Utilization of the Questionaire

To determine if emotional experiences (as described by the female adolescent: 12 - 14 years of age) do coincide with what attitude change/formation theorists suggest, an appropriate instrument must be utilized. In this particular case, the overall scientific attitude of the female adolescent is not of concern. Rather, this study attempts to

determine if such established negative affective orientations exist because of the female's specific "emotional (psychological) experiences" in the middle school science classroom. In other words, do females entertain an attitude change toward science from positive (in elementary school) to negative (in high school) because of experienced cognitive dissonance, modeled stiumuli, self-perceptions, and/or contingent reinforcement as implied by Festinger, Bandura, Bem, and Skinner (respectively).

Although Munby (1983) has recently compiled a collection of reliable and valid instruments which measure scientific attitudes of males/females/elementary age students/ high school students, etc., there is no established recommendation for evaluating directly whether positive relationships exist between these orientations and attitude change/formation theories specifically. A method to test for such associations must employ a combination of instruments.

An open-ended questionaire was selected to gather data. This instrument, validated for measuring scientific attitudes, elicited a wide range of responses. From these initial answers a follow-up questionaire, composed of four additional open-ended questions derived from "phrases" repeatedly included in the original replies, was constructed and used to collect data. The second questionaire presented four dichotomous inquiries, with an explanatory response

requested for each answer.

Although utilization of questionaires has been criticized for its serious limitations in quality and quantity of response (Engelhart, 1972), the United States Office of Education, the Research Division of the National Education Association, and other government educational organizations recognize that such procedures are unavoidable. Further, Munby acknowledges (1983) that the utilization of questionaires is more than acceptable if sufficient research and preparation have gone into the instrument employed.

Distribution. To establish whether correlations exist between attitude change/formation theories and negative scientific attitudes of female adolescents (ages 12 - 14), a two-step procedure was employed. First, a copy of Lowery's questionaire Projective Test of Attitudes [Part C] was distributed to 282 middle school students (152 females and 130 males). Upon receipt of the original responses a follow-up questionaire consisting of four additional open-ended questions derived from frequently stated "phrases" on Lowery's instrument was constructed. This was then redistributed to the same classes of students as participated in the first questionaire (357 students: 180 females and 177 males). The instruments were teacher administered with no further explanation than to "complete the form." The school participating in the data collection

was a middle-class suburban school located in the northeastern section of Greater Cincinnati.

Although the same classes of students were employed, a significantly higher number of questionaires was returned the second time. It is important to note that the class in which these questionaires were distributed was Music (so not to unduly influence the students' responses, separation from specific science teachers/classes was necessary). Also, Lowery's instrument was distributed the first week of school ('84-'85) and the follow-up questionaire was distributed after the seventh week of classes. As explained by the music teacher, many students opt for additional music classes (as electives) in place of pre-scheduled study halls. Consequently, upon the second distribution many students were present who had not enrolled in the class until the second or third week of the semester. Of further importance, due to the "captive audiance" nature of the classroom, 100% return existed. All students present for each data collection session completed the instrument and returned it to the teacher.

The sample questioned was predominantly white (only 5 minorities in a student population of 323); the majority of participating students were from middle income homes. Over 75% of the parents held blue collar or low level managerial white collar employment positions. Frequently the mother worked outside the home. Two-parent families predominated,

although many times both adults were not natural parents to all children. Approximately 11 - 17% of the households were run by a single individual (most often parent, but sometimes grandparent).

The participating northeastern Cincinnati suburban school population for years had been very stable. Recent development however, welcomed relocated families. The few parents reported by the school as highly-paid managers were identified as transients. The majority of the families however, had been in the area for two or three generations.

Finally, most of the students polled had been in class together since first grade. (Note: The above information was supplied by the principal.)

Instruments. As previously mentioned, Lowery's Projective Test of Attitudes was the initial questionaire distributed. As a projective test of scientific attitudes, it consists of three parts: (1) a word association test, (2) an apperception test, and (3) a sentence completion test. Established by the consistency of scores among the projective techniques, the validity of this instrument rests on the percentage agreements in excess of 80%. The inter-rater reliabilities for three judges are reported as: science: .92, process: .87, and scientists: .81.

Existing literature already sufficiently establishes that female adolescents possess significantly more negative attitudes toward science than males. The purpose of this

study is to determine if sufficiently repeated free responses appear among the female adolescents' returns to indicate "how" girls develop negative attitudes toward science. If repetition of answers occurred these phrases would then be incorporated into a follow-up questionaire eliciting possible responses relating to attitude change/formation theory constructs. Only Part C of Lowery's Projective Test of Attitudes, which consists of nine very open-ended questions, was used (See Appendix 1).

From Part C of Lowery's questionaire several repeated phrases were identified. For example:

(1) "[scientists] ...are so caught up in their own work..."

(2) "[some people are against science because] ...people make you feel stupid if you do something wrong... sometimes even the teacher..."

(3) "[science is] ...boring..."

(4) "[experimenting in science is] ... hard..."

A follow-up questionaire based upon these statements was constructed. This instrument included four dichotomous questions with an explanatory response requested for each answer (See Appendix 2).

Although both questionaires were distributed to male and female students (so not to "single-out" either group) the repeated examples discussed below represent high percentage occurrence of female responses. Although percentage occurrence of male replies is also recorded, only

in those instances where a gender comparison provides additional insight will male responses be analyzed.

Results of Data Collection.

Following are the recorded results of the data collected in this study. Table 1, Table 2, and Table 3 illustrate both male and female responses. Table 1 represents the percentage occurrence of free reponses to Lowery's Projective Test of Attitudes (Part C). Table 2 includes the percentage occurrence of responses to the dichotomous follow-up questions. Table 3 cites the percentage occurrence of free responses elicited by the follow-up instrument.

Lowery questionaire. As noted above, Lowery's Projective Test of Attitudes [Part C] elicited several specific phrases. The percentage occurrence of each statement is presented in Table 1. The three most frequent replies occurred 83%, 76%, and 52% respectively.

Although Lowery's instrument maintains a validity which rests on the percentage agreements in excess of 80%, the above phrases are noteworthy for two reasons. First, supportive data for negative scientific attitudes were not being gathered. If this was the intention, then other replies, although not word-for-word, could have been interpreted as similar in response. Although many of the repeated answers were below 80% agreement, specific phrases

TABLE 1

Occurrences of Free Responses
to
Lowery's Projective Test of Attitudes (Part C)

Response *		Percent Occurrence	
		Male	Female
[science is]...	boring	27	83
[scientists are]...	caught up (wrapped up) in their work... too involved ... too devoted	43	76
[some people are against science because]...	people make you feel stupid if you do something wrong... sometimes even the teacher	18	52
[experimenting in science is]...	hard...	8	46
	fun...	74	32
[scientists are people who]...	study...	20	42
[other people do not like to experiment in science because]...	they think things will go wrong... it's dangerous	14	31
[scientist are people who]...	experiment...	3	24

*Insufficiently repeated responses not recorded.

were repeated verbatum. Due to the fact that this questionaire strives to establish a core base from which to derive a follow-up instrument, any phrase repeated approximately 50% of the time or more is judged to be important.

Follow-up questionaire. Table 2 reports the percentage responses to four dichotomous questions relating to scientific attitude. As expected the majority of females answered "no" to the inquiry "Do you like Science?," and "yes" to "Do you think science is boring?"

The "yes/no" dichotomous questions, although unnecessary for purposes of this study (such negative female scientific dispositions were adequately proved through the "Literature Review"), are important for eliciting student emotional orientations. Prior to explaining "why" or "how" they understand something to be, students must recognize what it is they feel.

Table 3 summarizes student explanations outlined in the follow-up questionaire. Although the replies were open-ended, similarities did result. Over two-thirds of the girls (69%) responded that they do not like science because " ... it is too hard ... [and] ... I don't get very good grades." Interestingly enough, however, only 24% of all the female respondents mentioned that their parents punish them for doing poorly on a science test. (Most of these girls suggested that their parents "understood" science was hard

TABLE 2

Occurrences of Responses
to
Dichotomous Follow-up Questions

Question	Percent Occurrence					
	Male			Female		
	Yes	No	*	Yes	No	*
(1) Do you like science?	69	31	0	24	76	0
(2) Do other people make you like science?	26	62	12	73	14	13
(3) Do you think science is boring?	32	65	3	81	19	0
(4) Do you want to be a scientist?	40	38	22	19	78	3

* = Not Specified Dichotomously.

TABLE 3

Occurrence of Free Responses
to
Follow-up Questionaire

Response	Percent Occurrence	
	Male	Female
[I don't like science because]... it is too hard... I don't get very good grades...	23	69
[Other people make me like/dislike science]... my teacher/parents punish me for doing poorly on a science test...	62	24
[Other people make me like/dislike science]... teachers and otehrf kids make me feel stupid for not knowing things in science...	N/A	76
[I would not like to be a scientist because]... they keep to themselves...	22	71

for them.) In contrast, 52% of the boys said that they were punished either by their teacher or their parents for bad grades in science.

Additional data reveal that 76% of the female students made reference, in their responses to question #2, to their perception that teachers and other students make them feel "stupid" for not knowing the meaning of "hard words" used in science class. Only 26% of the boys made any reference to this however.

The final question (#4) also represented significant similarity of responses. Seventy-one percent of the females implied that they would not like to be scientists because scientists "... keep to themselves..." Thirty-eight percent of the males also replied that they do not want to be scientists. Their explanations for why however, varied widely.

The following section analyzes female response above 50%. Answers elicited less than 50% are insufficient to warrant interpretation. Where a gender comparison provides additional insight, male responses will also be discussed.

Analysis of Data

The data suggest that Festinger's Theory of Cognitive Dissonance and Skinner's Theory of Operant Conditioning do operate synergistically with the sex-role socialization process to explain <u>how</u> such female negative attitudes toward

middle school science evolve. On both the Lowery Projective Test of Attitudes and the follow-up questionaire middle school age females responded that they are made to feel "stupid" in science class (52% and 76%, respectively). Brookover et.al.(1974) described the female adolescent as confused and in a state of emotional disequilibrium. Data from the current study support that she feels unsuccessful and "stupid" in class (Kahle). Simultaneously, the female believes science is important (Hill and Lynch, 1983). Festinger cites such conflicting cognitive elements as causes of emotional tension. He further reports that if societal pressures induce an individual to behave contrary to his/her beliefs, the person tends to change beliefs so they become more consistent with his/her behavior (Snyder and Ebbesen, 1972). The theory of Cognitive Dissonance explains that changing one's beliefs eliminates a dissonant cognition, thus alleviating emotional tension or psychological dissonance (Festinger, 1957).

The consistency of negative scientific attitudes among female adolescents, when just a few years earlier they were positively oriented toward educational science, may be a function of cognitive dissonance. Specific applicability of this explanation however, relies on "social pressures." Seventy-three percent of female adolescents responded that "other people" make them like/dislike science (Table 2). Seventy-six reported that teachers and other students make

them feel stupid in class (Table 3). Although the girls did not specify whether the teachers and "other kids" were male or female previous discussions identified both groups as powerful social influences (See "Socio-Cultural Influences").

Skinner's Theory of Operant Conditioning is implied by the female respondent's acknowledgement that only 24% of their parents actively reprimmanded them for poor performance in science. The majority revealed that their parents "understood" science was difficult for them. In review of Skinner's [Contingent Reinforcement Principle] theory, such parental reaction could be construed as positive reinforcement for low expectancy of one's behavior in the classroom, low achievement levels in science and subsequent negative attitudes. McClosky's research stating that low achievement relates to negative attitudes warrants this assertion (1976).

Bem's Theory of Self-Perception may also explain middle school female attitudes. Sixty-nine percent of the females who responded that they do not like science said it was because "... I don't get very good grades ..." This may be interpreted that the girls who explain that they do not like science because they perform poorly on tests means "I don't know how I feel, but since I do badly I must feel badly about it." Bem's belief that attitudes are actually one's disposition as <u>inferred</u> from his/her overt behavior seems to

be upheld by responses to question #1 (See Table 3). To the extent that internal cues are weak, ambiguous, or uninterpretable, the individual must rely on overt behaviors to infer inner states (Bem, 1972, p.2) The adolescent female seems to recognize her low achievement in science and infer a negative emotional orientation accordingly (McClosky).

The only theory not indicated as facilitative (within the sex-role socialization process) of female negative attitudes toward science is Bandura's Theory of Modeling. Due to support of existing literature for the presence of such constructs in attitude formation, the lack of modeling indicators here may result from the instruments or method of distribution employed rather than from theory inapplicability. Although a few of the female responses referred to specific characteristics of their teacher, these replies were inconsistent throughout the questionaires. Further, in those cases where teachers were said to make the girls feel "stupid" there was no indication that the student would not want to study science because of this particular trait.

CHAPTER IV

CONCLUSION

This study suggests that attitude change/formation theories can explain how 12 - 14 year-old female adolescents develop negative affective orientations toward middle school science. More explicitly, Festinger's Theory of Cognitive Dissonance and Skinner's Theory of Operant Conditioning [Contingent Reinforcement Principle], both synergistic to the sex-role socialization process, account for the psychological discomfort and contingent reinforcement (respectively) experienced in the science classroom which prompts the formation of negative attitudes toward science. Data also support Bem's explanation which suggests that the adolescent female "infers" her attitude toward science from her overt behavior. Following is a brief discussion of the implicatons and recommendations of this study.

Discussion

Although this study encompasses data which support the above mentioned claims, additional research is needed. The incorporation of Lowery's Projective Test of Attitudes and the subsequent follow-up with an additional open-ended questionaire represent appropriate but insufficient data collection. Although not presently available, an instrument should be devised, and test results procured, which directly

measure relationships between attitude change/formation theories and scientific affection.

This paper provides the groundwork for additional study. Positive relationships are suggested between female adolescents' scientific attitude formation and Cognitive Dissonance, Self-Perception, and Conditioning. The lack of association between modeled stimuli and scientific attitude formation however, needs to be further explored. Literature is aware of discrepancies between sex-appropriateness of behavior and imitability (See "Science and the Socialization of Females"), but does support modeled stimuli as representative of "how" attitudes are formed (Denmark and Goodfield, 1978).

Recommendations

Further research is required. For educational institutions (specifically) and society (in general) to be able to take steps toward the improvement of female adolescents' attitudes toward middle school science, and subsequent achievement and future attainment in scientific careers, better understanding is needed of how middle adolescent girls form scientific attitudes.

This paper recognizes many implications which need further attention. The most important consideration however, regards the phenomenon of sex-role socialization. If psychological discomfort, social reinforcement, and inferred

attitudes from overt behavior (via sex-role socialization) are main causes of how and why female adolescents become negatively oriented toward science, the only way to abate such emotional experiences is by eliminating the sex-stereotyping present in the classroom. Assuming such a task is possible, what repercussions echo from this accomplishment? Some authors believe adolescent development and role-identy are significant problems now because our culture inadequately delineates between the sexes. A move to a more "androgynous" society and the effects such an evolutionary step suggests must be further investigated.

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APPENDIX 1

Lowery's Projective Test of Attitudes [Part C]

SCIENCE COMPLETION TEST

Students: Please complete the following sentences. Put your age and sex at the top of the page. Your Teacher will collect your responses when you are finished. Thank you.

1. The field of science is:

2. Most people like science whenever it:

3. One thing that puts some people against science is:

4. Experimenting is science is:

5. Some people find experimenting enjoyable because:

6. Other people usually do not like to experiment because:

7. Scientists are people who:

8. People admire scientists because:

9. Some scientists are unpleasant people because:

APPENDIX 2

Follow-up Questionaire

Student's Age:

Student's Sex:

Students: Please complete the following:

(1) Do you like science? Why?

(2) Do other people make you like/dislike science? Explain.

(3) Do you think science is boring? Explain.

(4) Do you want to be a scientist? Why?